5

ontario hydro

ENVIRONMENTAL ASSESSMENT PROPOSED GENERATING STATION FOR DARLINGTON

GENERATION PROJECTS DIVISION

ontario hydro

ENVIRONMENTAL ASSESSMENT PROPOSED GENERATING STATION FOR DARLINGTON

GENERATION PROJECTS DIVISION
APRIL 1975

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 PROPOSAL FOR DARLINGTON GENERATING STATION A

1.1 INTRODUCTION

This document indicates the intention of Ontario Hydro to seek approval from the Provincial Government for its plan to construct and operate a 3400 MWe nuclear generating station at the Darlington site, west of Bowmanville. This preliminary proposal also contains the environmental assessment.

The environmental section of this proposal describes and assesses the existing environment and the environmental influences which would occur due to the construction and operation of a nuclear generating station, consisting of four 850 MW units, at the Darlington site. This proposed station is similar to the Bruce GS A station presently under construction. The proposed station will be designed, constructed and operated using proven technology and with the most up-to-date features to minimize the environmental impact.

1.2 SUMMARY

A long range program to meet the Province's electrical power needs was tabled in the Ontario Legislature in June 1973. This program included fossil-fired stations at Wesleyville and in the Thunder Bay area, nuclear stations at Pickering, Bruce and Darlington and an extension of the Bruce Heavy Water Plant.

This proposal covers the new generation required for 1983. It is proposed that this generation be provided by an additional 3400 MW nuclear station to be located at Darlington, comprising four 850 MW units. In order to meet the first unit in-service date of 1983, construction should start no later than the spring of 1976. One unit would come into service in 1983, one in 1984 and two in 1985. The station is forecast to cost $3,080,000,000 (1984 dollars).

Copies of this preliminary proposal which includes the environmental assessment are submitted to the Minister of Energy and to the following interested ministries:

Ministry of the Environment

Ministry of Natural Resources

Ministry of Agriculture and Food

Ministry of Housing

Ministry of Health

Ministry of Labour

Ministry of Transportation and Communications

Ministry of Industry and Tourism

Ministry of Treasury Economics and Intergovernmental Affairs

and also the Provincial Secretary for Resources Development

A supplementary document to this preliminary proposal entitled "Supplementary Report on Cooling Water Systems for Darlington GS" is being prepared and will be issued in June 1975.

Meetings with local officials and the public are planned to explain the expansion program and discuss the concerns of community residents and local officials.

1.3 REQUEST FOR APPROVAL

This is a preliminary proposal which Ontario Hydro is submitting as information for the Government and the public. Ontario Hydro intends to solicit views on it from the public and the responsible Ministries within Government. The response will be considered by Ontario Hydro before reaching a decision to change the proposal or confirm the proposal in a final form. Following this decision Ontario Hydro will seek Government Approval of its final proposal.

1.4 THE NEED FOR NEW GENERATION

The main pressure for developing additional generation arises from the growth in electrical load. A secondary factor is the degree of reliability with which the power is to be supplied, and the amount of reserve generation needed to meet the reliability target. This in turn is dependent upon the capability of the operators and apparatus to accommodate a spectrum of contingencies without causing any loss of electrical service to Ontario Hydro's customers.

Darlington GS was originally scheduled for a first unit in-service date of July 1982. Delay in commencement of design and construction now makes the original scheduled date unachievable.

The issue of the need has been examined at the Ontario Energy Board hearings, during 1974, and the Ontario Energy Board Report which was issued in August, 1974 generally accepted our load forecast and the need for more generation.

1.5 THE CONSIDERATION OF ALTERNATIVES

In determining a course of action for any system as complex as electrical supply, a large number of alternatives must be evaluated. Some of the more important of these are discussed below.

1.5.1 The Alternative of Not Providing Generation

Short of a major catastrophe or an economic depression, the load forecast for the period up to 1982 could probably only be reduced by the voluntary action of customers or by government control. There is a high probability that the load will occur, and therefore, failure to bring the proposed plant into service in 1983 would substantially reduce the system reserve. This would cause a marked decrease in the reliability of supply. Therefore, the Darlington GS project is being proposed for first in-service in 1983.

1.5.2 Alternative Sources of Additional Generation 1977-1983

(i) Purchases

Further purchases of firm power from Quebec, Manitoba and Saskatchewan are under recurring review. At present for the period 1977-1983, purchases from Quebec seem unlikely. Purchases from Manitoba and Saskatchewan are not practicable at present for the East System but are being examined for the West System.

(ii) Hydraulic Capacity

The remaining undeveloped hydraulic capacity in Ontario is either small in terms of its energy-producing content, or it is located at large distances from existing load centres. The few sites which may be economic for development in the period 1977-1983 will not substantially affect the need for new fossil-fuelled and nuclear capacity on either the East or West Systems.

(iii) Pumped Storage

Some potential pumped storage projects are available but these will not be economic until a large additional amount of nuclear capacity is developed.

(iv) Combustion Turbines

These units are relatively new on the market and have suffered from poor operating availability, but there are indications that their reliability is improving. They require premium fuels and are not

economic for generating large blocks of energy. In the period 1977-1983, some units may be usefully installed on the West System; but they do not appear desirable for installation on the East System except as a stop-gap.

(v) Conventional Fossil Generation

Since 1960, the fossil-fired plant has been the primary means of meeting load growth in the absence of further large water power developments. Reliability has been a continuing problem, but constant effort and development have brought it to an acceptable level. However, there are great uncertainties surrounding the future supply and cost of acceptable fossil fuel, and also many difficulties impeding the development of practical commercial methods for treating either the fuel or flue gas to reduce noxious emissions to the atmosphere. These problems enhance the relative position of nuclear generation and make it the favoured alternative for the future. Because of its lower capital cost and higher operating cost, fossil generation is more economic than nuclear at low capacity factors, but less economic than nuclear at moderate and high capacity factors.

(vi) Nuclear Generation

Because of lower fuelling costs, CANDU nuclear generation is more economic than fossil at moderate and high capacity factors, even though its capital cost is higher. Nuclear generation appears more acceptable from an environmental point of view. The security of supply of nuclear fuel in Ontario is much better than fossil fuel which must be imported.

The reliable production of heavy water needed by the CANDU reactor is vital for predicting the in-service dates of nuclear units. At present, the Bruce Heavy Water Plant A is operating successfully, two additional plants are under construction, and approvals are being sought for additional heavy water plant. It is believed that heavy water will be available in the quantities required for the nuclear generating units covered in this proposal.

Proposal

In view of our confidence in adequate heavy water supply and reliability of fuel supply and the economic advantage for this high capacity factor station, together with our belief that nuclear generation appears more acceptable with regard to environmental considerations, nuclear generation is proposed to meet the 1983 forecast needs.

1.5.3 Alternatives for Station Location

The generating station must be located on a site already owned by Ontario Hydro and should be situated close to the load it will serve in Southern Ontario.

Ontario Hydro owns five sites in this area:

Pickering site, east of Toronto;
Lennox site, west of Kingston;
Wesleyville site, west of Port Hope;
Darlington site, west of Bowmanville;
Bruce site, on Lake Huron between Kincardine and Port Elgin.

A 2000 MW oil-fired station is currently under construction at the Lennox site and the first unit is scheduled for commercial service in June 1975. A 2000 MW oil-fired station is currently under construction for the Wesleyville site and the first unit is scheduled for commercial service in April 1979. A 2000 MW nuclear station addition is currently under construction at Pickering and the first unit is scheduled for commercial service in 1980.

A 3000 MW nuclear station addition is currently proposed for the Bruce site and the first unit scheduled for commercial service in 1982.

Continuing environmental studies have been carried out on each of these sites, to establish their capability to accept specific types and sizes of generating stations.

Proposal

It is proposed that the station be sited at the Darlington site.

1.6 PROJECT CAPITAL COSTS

An estimate of station capital cost is given in both 1975 and 1984 dollars. The 1975 figures are for a hypothetical station that is built and operated in 1975 costs, and are provided for reference to current costs.

	1975 Dollars	1984 Dollars
Station capital cost	1,769,000,000	3,080,000,000
Net installed kilowatts	3,400,000	3,400,000
Dollars per net kilowatt	520	906

2.0 SUMMARY OF ENVIRONMENTAL ASSESSMENT

INTRODUCTION

This document describes and assesses the existing environment and the environmental influences which would occur due to the construction and operation of a proposed nuclear generating station, Darlington GS A, on a site west of Bowmanville, and the site and shoreline modifications required for a future extension to the proposed station. The proposed generating station, basically similar to the Bruce GS A units, will be designed, constructed and operated using proven technology and with the most up-to-date features to minimize any environmental impact. The views of the regulatory authorities and responses from the public may add to or change the factors considered in this document.

2.1 GENERAL PRINCIPLES

Development of the proposed generating station site and construction will not start until after regulatory agency approval has been received and will conform to all relevant local, regional, provincial and federal government criteria and regulations.

Control of emissions will be based on the objective of achieving the lowest practicable levels and having the minimum influence on the environment.

Safety measures incorporated in the proposed station will meet all initial requirements and regulations, followed by regular in-service inspections to maintain its safety and reliability.

The method of incorporating the proposed Darlington site development into the grid system will be based on proven technology and will take into account the distance from the site to the grid, present land use, regional development plans and environmental influences.

2.2 AIR

Existing air quality in the site area is considered to be good due to the absence of large emission sources.

Winds will be over land approximately 35% of the year.

The frequency of atmospheric inversions is expected to be typical of other adjacent Lake Ontario sites.

Radioactive waste management systems will be provided to meet the design target of 1% of Derived Release Limits based on the maximum

permissible radiation dose to an individual at the site boundary. Based on Pickering GS A experience yearly average airborne releases, not taking into account the planned installation of an off-gas treatment system, are expected to meet the 1% design target level.

During construction, local air quality will be adversely influenced by dust from site construction activity, traffic along trucking routes, and burning of construction waste material. Effects will be very localized and of a temporary nature.

Ground level concentrations of emissions from the standby generator-combustion turbine units, when occasionally operating, will be well within the regulatory limits and will not cause injury to sensitive vegetation in the area.

2.3 WATER

Existing water quality is good due to the absence of major municipal and industrial pollution sources nearby. Inshore, nutrients are retained for a period in spring due to development of a thermal bar. Extensive turbidity occurs largely due to shoreline erosion. Eutrophic conditions sometimes occur in the nearshore area, but in the offshore zone mesotrophic to oligotrophic conditions exist. Conditions are generally similar to those recorded at other Lake Ontario sites.

Lake currents are predominantly along the shore with the net transport to the west and southwest.

Ambient lake temperatures show wide daily fluctuations, consecutive daily mean differences being recorded as high as 13F° at the location of the proposed cooling water intake. Over a study period of two years the maximum hourly mean temperature at the intake location was 71°F.

Ice cover at the site is not extensive, and consists of shore and slush ice.

The present commercial fishery in the area is small and is almost entirely based on smelt fishing.

Fish populations near the site are low and consist predominantly of alewife and suckers. Species diversity and populations of benthic organisms are similar to conditions at other Lake Ontario sites, such as Pickering and Wesleyville.

The growth of Cladophora, a nuisance alga, is relatively dense near the site.

During the construction period, water quality will be mainly influenced by construction of the offshore cofferdam. Dredging will cause water turbidity, but due to the nature of the bottom sediments settling will be rapid and localized. Resolution of nutrient materials and any heavy metals will be negligible. A beneficial effect on water quality at the site and along the adjacent shoreline is expected due to reduction of shoreline erosion.

The sewage lagoon system will be designed to meet peak construction manpower loads as well as long-term loads and will be designed according to regulatory agency criteria. During commissioning of the station; fluorescein, morpholine and hydrazine will be retained in the sewage lagoon until condenser cooling water is available for adequate dilution in the lake. Overflow to the lake will be treated to remove phosphorus and is expected to be on a seasonal drawdown basis.

Lake currents and littoral drift patterns will be modified in the immediate site area due to the shoreline modifications. Some trapping of drift material may occur on the sides of the cofferdam.

Excavation will result in changes in ground water levels, but these changes are expected to be confined within the site area.

Benthic and other aquatic organisms associated with the section of shoreline to be reclaimed will be eliminated, but some habitat for recolonization will be provided by the rock surface of the cofferdam. Drilling and blasting may kill fish locally which are not discouraged by other construction activities. Sedimentation will eliminate the benthos in the immediate area outside the cofferdam, but it is expected that some recolonization will occur.

During operation, with the proposed cooling water discharge arrangement the thermal discharge will increase lake surface temperatures by 14-19F^{o} near the discharge point, depending on the season, but surface temperatures will decrease to 2F^{o} above ambient at distances of 2-3 miles from the discharge point. Under conditions of onshore winds, approximately 3/4 of a mile of shoreline will be exposed to transient temperature increases of 9-14F^{o} above the prevailing lake surface temperature.

Current modifications near the submerged intake will occur, but will not noticeably influence lake surface movements.

Water quality changes due to the addition of heat and the discharge of other station effluents are predicted to be small. Naturally occurring high dissolved oxygen levels are not expected to be reduced. Some slight nutrient recycling may occur in the summer months, but levels are not expected to be high enough to promote algal growth.

The mobility of the surface discharge, in conjunction with variations in the station thermal output, will tend to discourage long-term residence of fish in the thermal discharge area. Salmonids would be

exposed to potentially lethal temperatures if attracted to the thermal discharge in the warmer months of the year, but present evidence is that these fish leave nearshore areas during this period. Potentially lethal conditions would only occur for non-salmonids at the point of discharge when lake temperatures approach or exceed maximum recorded daily mean temperatures.

Shoreline turbidity and exposure to storms are factors contributing to the present low levels of spawning activity in the area. Transient thermal influences down to a depth of 20 feet and extending for a distance of up to 3,000 feet along the shoreline are not expected to have any significant effect on spawning.

Benthic fauna composition and populations are expected to undergo some shifts in the immediate discharge area due to increases rather than decreases in numbers. No changes are expected that could be considered irreversible or as contributing to nearshore ecosystem instability.

Epiphytic algae populations may become dominated by green algae forms in the warmer months, but blue-greens are not expected to become dominant. Algal blooms are not expected to be caused by the thermal discharge. Filamentous algae may grow and fragment slightly earlier and appear in the discharge area and the standing crop may be increased in localized areas where currents are strong.

Entrainment damage to plankton, small fish and other aquatic organisms will result from thermal stress, mechanical abrasion, and pressure changes in the condenser cooling water system. A quantitative measure of damage and the significance of such damage on the nearshore aquatic ecosystem cannot yet be provided. The use of a submerged offshore intake is expected to minimize the intake of adult fish.

Releases of radioactivity to the station condenser cooling water discharge will primarily be on a batch basis from collection tanks following laboratory analysis and will be controlled such that the yearly averaged design target of 1% of the Derived Release Limits will be met. This will ensure that the concentration of radionuclides in water available to the public will be a very small fraction of the maximum allowable.

Water treatment plant wastes will be discharged at a pH which will not affect the total station discharge by more than 0.5 units with respect to the natural lake pH.

If appreciable phosphorus addition to the boiler feedwater is found to be required, it will be removed within the water treatment plant with no subsequent release of phosphorus to the lake.

Recovery systems for removal of oil from routine oil-contaminated water flows and from acute spillage or leakage will be developed and installed.

Discharge of oily wastes and chemicals used in station operation will be controlled to conform with any present and future water quality criteria.

The use of water for condenser cooling and other station processes is expected to have no adverse influence on other industrial or public water uses in the area.

2.4 SITE AREA

The Darlington site has an area of approximately 1,200 acres which would be augmented by approximately 120 acres by the proposed reclamation into the lake. The proposed station will be located on the western portion of the site and will occupy the western half of a possible future two-station layout having central common service facilities.

The site is located in a seismic zone with minor earthquake damage probability.

There are no marshes on the site. The site shoreline is presently not well suited for swimming or other water-related activities.

The site occupies property having Class I soil. Up until the time of purchase, approximately half of the site area was in pasture for cattle, with the rest of the land under cultivation, wooded, or occupied by small orchards. Site clearing will involve the loss of two apple orchards and some small clusters of trees in addition to those trees associated with site boundaries and road allowances. Only that vegetation which is within site areas planned for actual construction activity will be removed. Care will be taken to preserve as much of the vegetation on other areas of the site as is possible.

Extensive excavation and filling will be required to bring the powerhouse area down to the required grade elevation above lake level. This will necessitate offshore expansion of the site by reclamation of approximately 120 acres. The shoreline modification will have a temporary adverse effect on water quality. Natural siltation along the shoreline due to cliff erosion will be reduced due to the rock facing on the extensions into the lake.

Ion exchange resins, filters and various other radioactive wastes will be stored both at the station and later at a central waste management facility operated by Ontario Hydro. Spent fuel will be stored at the station for several years before being transferred to a central storage facility at some time in the future.

2.5 COMMUNITY AND LAND USE

The only large urban development within 5 miles of the site is Bowmanville. The City of Oshawa lies approximately 6 miles to the west and Newcastle lies 7 miles to the east. Approximately 15,000 people live within 5 miles of the site, and 120,000 within 10 miles.

The official plan for the Bowmanville planning area recognizes that industrial activity will increase in the area and that it will continue to be a dormitory area for Oshawa.

The official plan for the Darlington planning area designates most of the shoreline between Bowmanville and the Darlington Provincial Park for industrial use.

The topography of the site of the proposed station will provide a natural screen between the station and the community of Bowmanville and along the MacDonald-Cartier Freeway.

Holt Road will be widened and rebuilt to two lanes. Temporary bridges will cross the CNR tracks during the construction period and will later be replaced by a permanent structure. A railway spur line will be constructed into the station area from the existing CNR line which crosses the site.

Traffic congestion, noise and possible road deterioration are problems which may result from truck hauling of construction materials for the cofferdam and other structures.

Approximately one quarter of the expected construction work force will move into the area bounded by Metropolitan Toronto, Peterborough and Cobourg. Shortage of labour in local industries may be aggravated by the labour demands of the project.

The main recreational facility in the area is Darlington Provincial Park. The area within 25 miles of the site is well provided with recreational facilities.

The transmission required to incorporate the Darlington site development into the grid will depend upon the location of the main 500 kV east-west transmission corridor which will link Lennox GS near Kingston, and Wesleyville GS near Port Hope with a proposed Oshawa Area Transformer Station (TS). The route of the Lennox-Oshawa transmission is the subject of public inquiry, now underway, by the Solandt Commission.

It is expected that the local economy will be improved by stimulation of further industrial activity in the area, and by local purchases of equipment and services, in addition to personal expenditures by construction and operating staff.

No significant impact from the construction force is expected on the educational, medical and recreational facilities of the area.

Noise on the site during construction associated with such equipment as pile drivers will be high, but noise levels at the site boundary however are not expected to be a nuisance to the community.

A grant-in-lieu of taxes on the property and administration building of the proposed project will be made to the new Town of Newcastle and on the plant and service facilities when the generating units become operational.

During operation of the proposed station there are expected to be no measurable physical influences on adjacent industries, agriculture, recreation and parkland facilities. There is not expected to be any undue burden on the medical, education, transportation or labour facilities of the area that would be different from any industry employing approximately 300 people.

Noise levels to the community during operation will not exceed normal background levels, except during possible occasional operation of steam relief valves. Noise abatement equipment and techniques will reduce noise to a low level at the site boundary.

Maximum permissible individual and population dose limits for members of the general public are specified by the Atomic Energy Control Board. Meeting design and operating targets of the 1% of Derived Release Limits will ensure that individual and population doses will be far less than the regulatory limits during the life of the station.

Operation of the proposed 500 kV transmission lines will not interfere with any electrical communication media. The right-of-way will be made available for uses which are compatible with the safe operation of the lines.

The proposed project is compatible with existing regional and municipal development plans.

3.0 PROJECT PHILOSOPHY

3.1 INCORPORATION

The Province of Ontario is served by an electric power transmission grid, developed over a considerable period of time to supply the power needs of municipalities, industry and agriculture. Generating stations of various types and sizes are incorporated into this grid to provide a power source of high reliability.

The system required for incorporating a particular station depends upon the distance of the station site from the grid, existing land use, environmental influences, regional development plans and existing technology. Plans for the proposed generating station provide for its transmission lines to run north from the site to the Oshawa Area TS. The site is close to the load centre. It is Ontario Hydro's intention to consider all of the foregoing factors in arriving at the transmission system and route for incorporation of these lines into the grid in the Oshawa area.

3.2 SITE DEVELOPMENT

Site development may directly follow the site selection and acquisition process or it may be delayed for several years. Development scheduling may depend on load growth, economic conditions, desire to prove out a new system before further development and requirements for environmental investigations on site.

Assuming approval for the proposed project is obtained, Ontario Hydro intends to develop the site in accordance with these interests and to closely monitor all phases of development to ensure effective control.

3.3 EMISSIONS CONTROL

Emissions control is concerned with such aspects of the proposed project as radiation, radioactive station wastes, non-radioactive station wastes, heat dissipation and noise. It is Ontario Hydro's intention to achieve the lowest practicable emission levels to avoid potentially harmful effects on the individual and on the environment. Monitoring will be carried out to ensure effective control.

The design target for routine airborne and liquid radioactive releases from Ontario Hydro nuclear generating stations is to be one percent of the Derived Release Limits (DRL) based on the maximum permissible dose to an individual resident at the boundary of the exclusion area.

The preferred method of dealing with potentially harmful emissions is to eliminate the sources. However, where management of emissions or wastes is necessary, it will be based on treatment, storage and/or dispersal in keeping with established practice and government

regulations. If storage is required, it will be in a stable form consistent with plans for future disposition. Facilities will be such that any leaks could be easily monitored and repaired. Transport of waste materials off site will be in accordance with government regulations or regulatory agency guidelines.

3.4 SAFETY

A major concern involving safety is the chronic and possible accidental releases of radioactivity from the proposed station. The Atomic Energy Control Board (AECB) is the federal regulatory authority responsible for licensing all aspects of site selection, construction and operation of nuclear generating stations. Ontario Hydro is responsible for ensuring that the station is designed to meet safety requirements that adequately protect the public. Detailed Safety Reports and other submissions are made to the AECB and are reviewed by the Reactor Safety Advisory Committee. It is Ontario Hydro's intention to construct a station which meets all safety requirements and regulations, and to undertake in-service inspections throughout the life of the station to ensure the station remains in a safe and reliable condition.

The basic control and protection philosophy for the reactors will incorporate a computer based regulating system separated to the maximum extent from a triplicated protective system. The protective system will include two completely independent and fully capable shut-down systems. Two computers, one being for backup, will be employed in each unit to reliably carry out many complicated control functions. An essential aspect of Ontario Hydro nuclear safety philosophy, a containment system consisting of a vacuum building and connecting pressure relief duct, will collectively contain any high energy fluids released within the reactor buildings following any conceivable accident to the reactor system. The combined overall control and protective systems will be designed to run the station in the intended manner and, when required, to shut it down safely with minimum damage to the station and the environment.

3.5 DESIGN, CONSTRUCTION AND OPERATION

Satisfactory fulfilment of project design objectives requires a comprehensive quality assurance program which will ensure that the project is designed and constructed in such a manner that the station can be operated efficiently and safely.

Important factors in such a program are competent personnel; clear and complete specifications, procedures and assignment of responsibilities; frequent review audits (functional, reliability, maintainability, radiation exposure liability, safety); skill re-certification; effective quality control with complete documentation; and development of quality consciousness in all participants. This program will be integrated into the design and construction of the proposed station.

Design of the main buildings and structures will take into account parameters such as earthquake forces and wind velocities calculated in accordance with the provisions of the National Building Code of Canada.

While the reactor buildings will be basically designed to shield personnel from radiation during normal operation or shutdown, the design criteria will also take into account factors such as maximum accident loads, normal gravity loads, snow loads, wind forces and earthquake forces.

In general, design and construction of the proposed station will be according to provisions of the appropriate codes and regulations for qualification of staff as well as for systems and equipment.

4.0 PROPOSED PROJECT DESCRIPTION

4.1 SITE LOCATION AND ACCESS

The proposed Darlington GS A is located on the west half of the Darlington site on the north shore of Lake Ontario at Raby Head in the new Town of Newcastle in the Regional Municipality of Durham (formerly Township of Darlington, County of Durham), latitude 43°, 51' 30" N, longitude 78°, 43' W. It is approximately three miles southwest of the community of Bowmanville, and approximately six miles east-southeast of the City of Oshawa (Figure 4-1).

The Darlington site occupies a land area of approximately 1200 acres, of which just over 1100 acres have been acquired to date by Ontario Hydro. This tract of land will be augmented by an area of about 120 acres, proposed to be reclaimed from the lake. The site property is bounded by the south service road of the MacDonald-Cartier Freeway to the north, and the lake to the south, and extends east-west from Lots 18 to 24, inclusive, in the Broken Front Concession. The total frontage of the site along the shoreline of Lake Ontario is about 9500 feet. The proposed Darlington GS A will occupy the half of the site west of the Holt Road in Lots 21 to 24, inclusive.

The site may be easily reached by car or rail. The multi-lane MacDonald-Cartier Freeway runs east-west immediately north of the site, with controlled exits less than two miles on either side. Holt Road is one of several township roads running north-south into the site area from the service road of the freeway. Rail access may be provided by the CNR main line which bisects the site in an approximately east-west direction with a station and siding presently located in the community of Bowmanville, about three miles northeast (Figure 4-2).

4.2 STATION CAPACITY

The proposed station will consist of four generating units of the CANDU pressurized heavy water reactor type, each capable of operating independently, but using certain common services. Each unit will be designed for a net electrical output of approximately 850 megawatts (MW) at a .85 power factor, with a station output of 3400 MW. Power will be delivered to the Ontario grid at 500 kilovolts and 60 hertz.

Combustion turbine units are currently planned to provide standby power of high reliability and to permit safe and orderly shutdown of the station in the event of a loss of normal power supplies. The combustion turbines may also be used for peaking capacity for the Ontario grid.

4.3 UTILIZATION AND PERFORMANCE OF STATION

Each unit will be designed for and evaluated on a 30 year economic lifetime average capacity factor of 80%. Each unit will be capable of sustained operation at any load between 50% and 100% of maximum rated capacity, and will be capable of shutdown for weekends or for any 36 hour period or longer.

Due to the relatively low operating costs of nuclear fuelled stations, the proposed Darlington GS A will be designed to operate as a base load station operating at the high capacity factors mentioned above.

The combustion turbine units, which will use a light distillate oil, will be run up periodically for testing and may be used during peak power demand periods for supplemental power. Total usage per combustion turbine unit is expected to average less than 600 hours per year.

4.4 SCHEDULE

The proposed schedule for conceptual design and preliminary engineering of the project is directed toward completing the first unit for service by July 1, 1983 and the remaining three units at successive nine month intervals.

Unit	Scheduled In-Service Date
1	July 1, 1983
2	April 1, 1984
3	January 1, 1985
4	October 1, 1985

If this schedule is maintained, site work should begin in the early part of 1976. The proposed project life cycle is shown in Figure 4-3.

4.5 MANPOWER REQUIREMENTS

Construction activities at the project are scheduled to commence in 1976. The total construction work force is forecast to peak in 1982 with an average for the year of 3900. It can be noted from Figure 4-4 that about 86% of this total would be construction trades with the remainder management staff.

4.6 GENERAL SITE LAYOUT AND PROPOSED STATION ARRANGEMENT

The proposed site and station arrangements are shown in Figures 4-5 and 4-6. The proposed station will be designed for the possible extension to eight units of which Darlington GS A will comprise the

FIGURE 4–1 SITE LOCATION

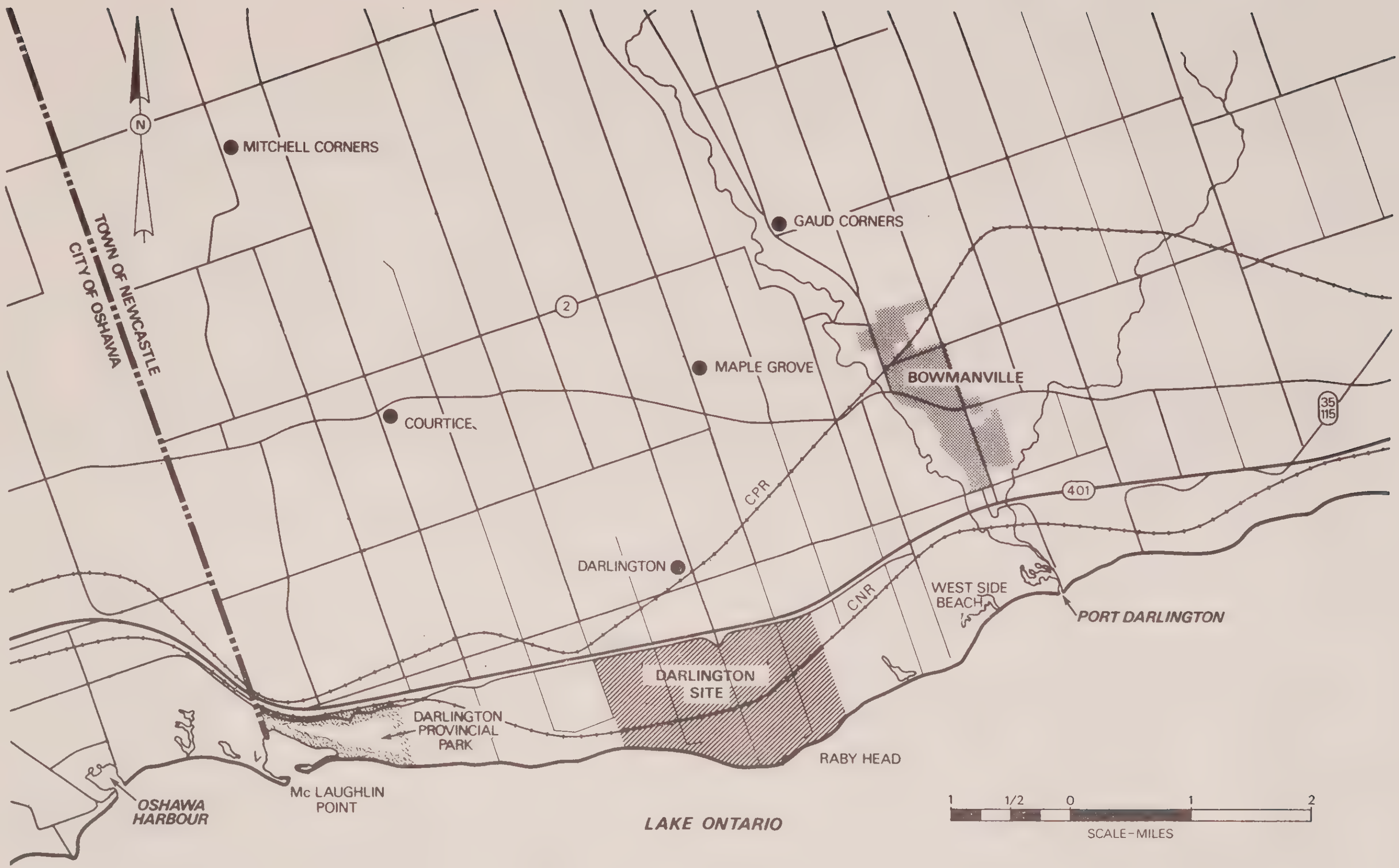


FIGURE 4–2 SITE AREA

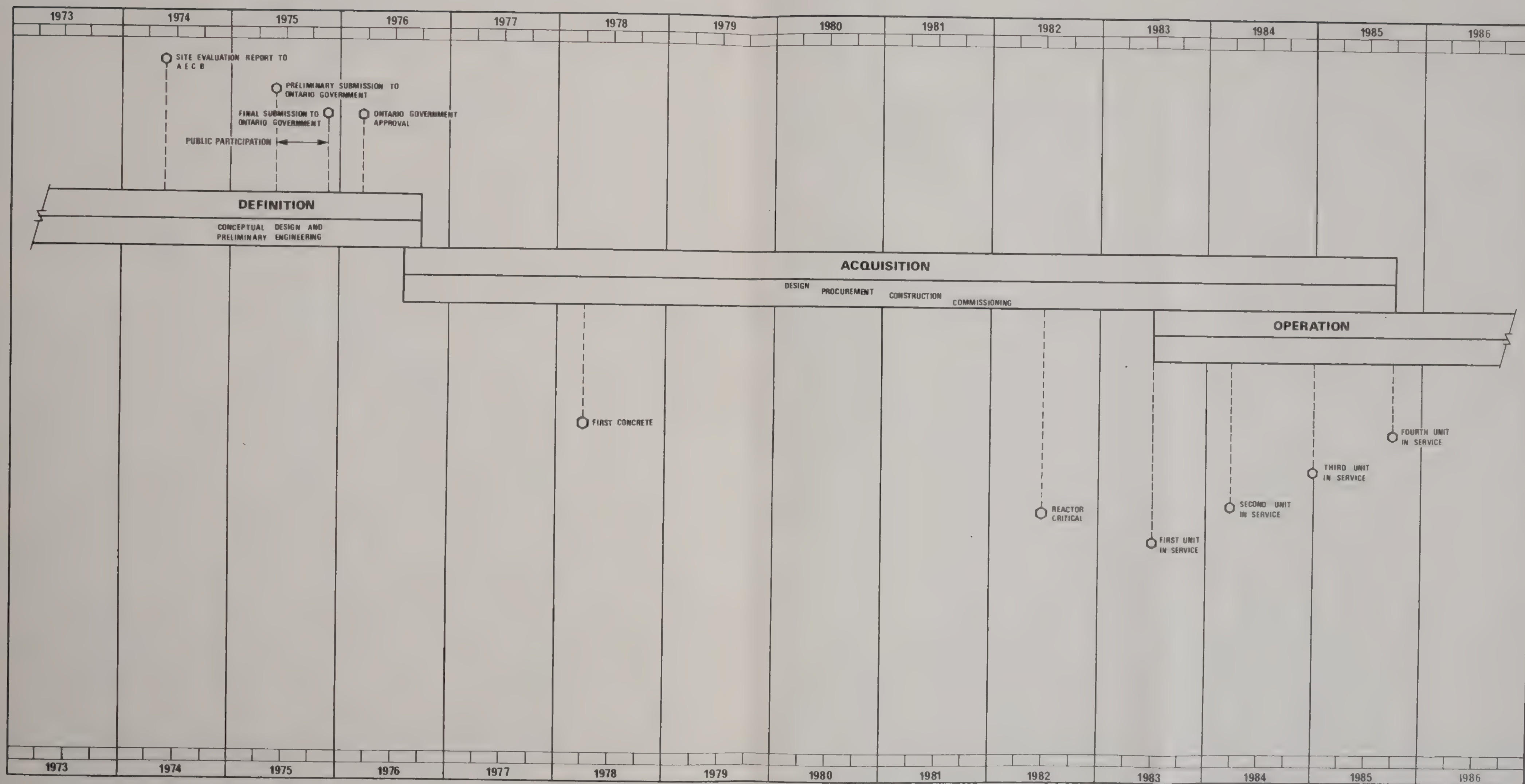


FIGURE 4–3
DARLINGTON GS A
PROJECT LIFE CYCLE

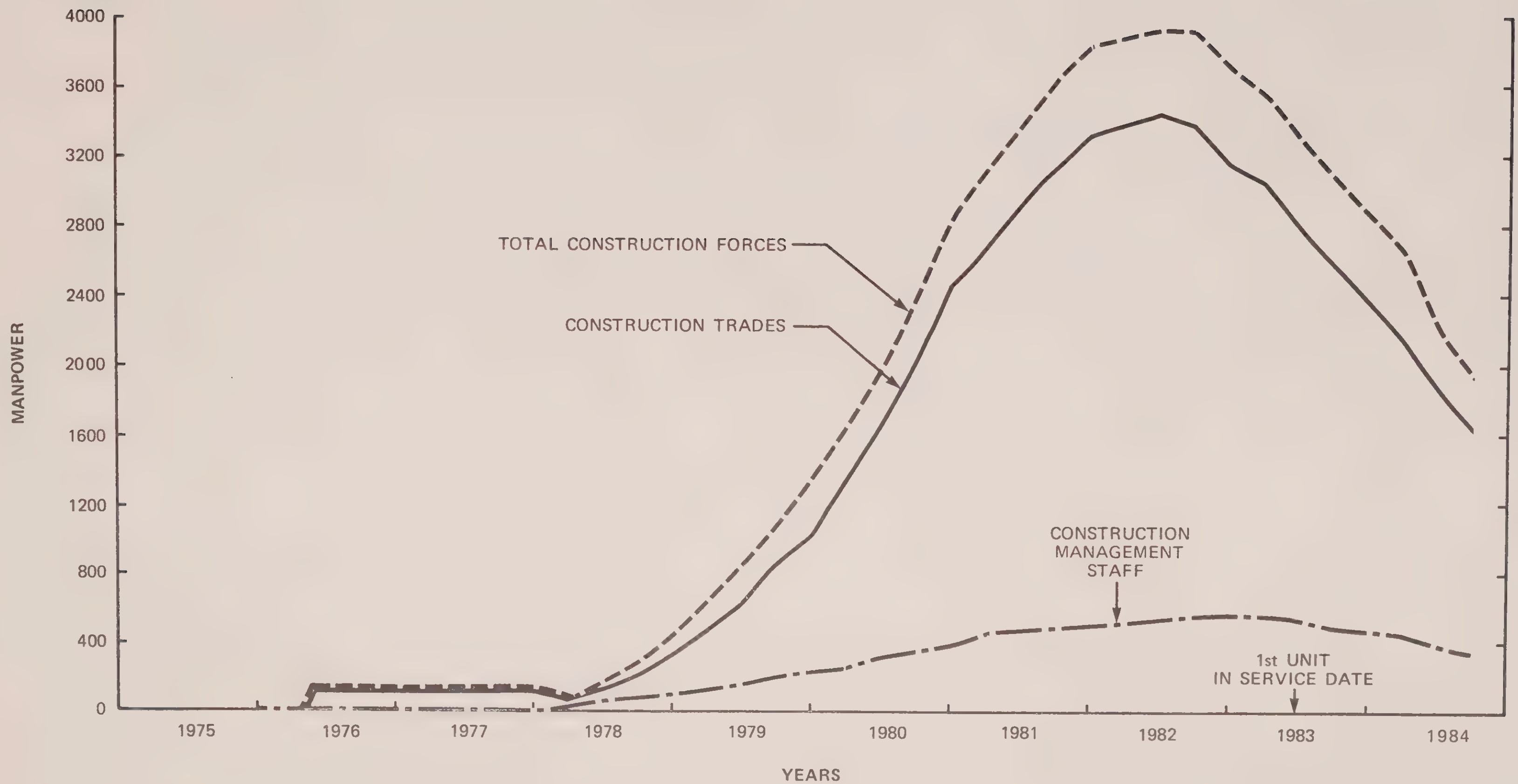


FIGURE 4–4 DARLINGTON GS A CONSTRUCTION MANPOWER FORECAST

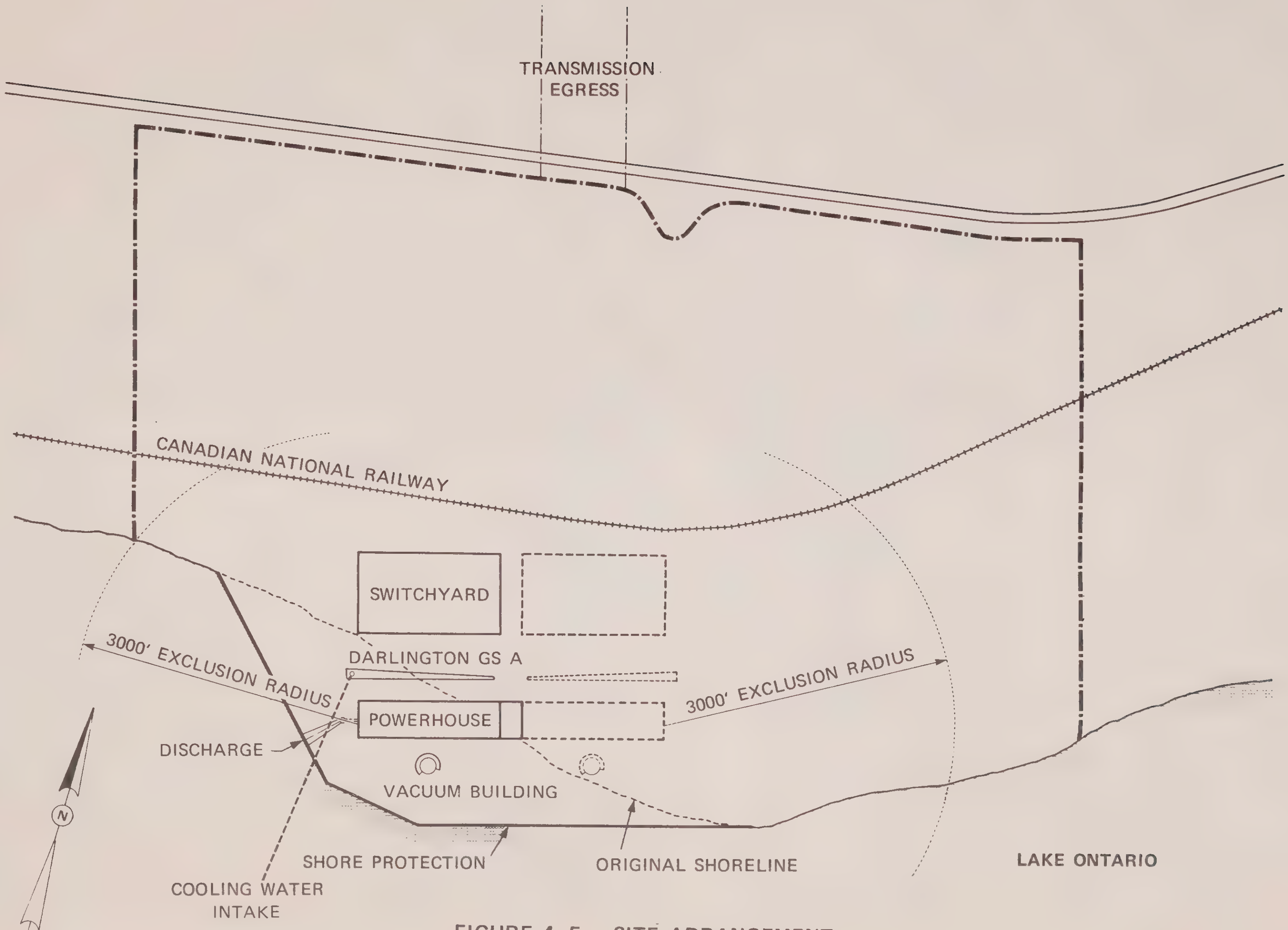


FIGURE 4–5 SITE ARRANGEMENT

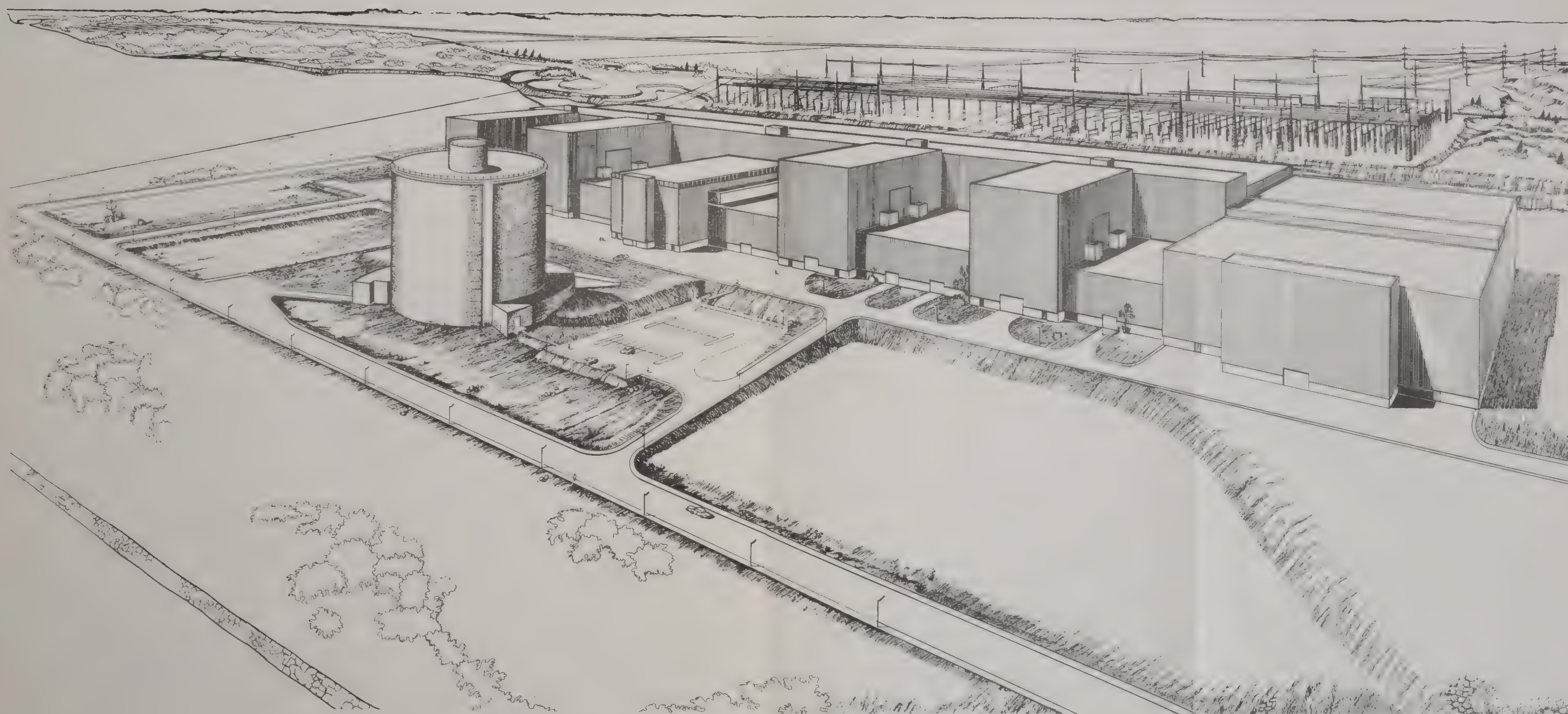


FIGURE 4–6
PROPOSED STATION ARRANGEMENT

first four. This arrangement was chosen on an economic basis of shared, centrally located common facilities for the possible eight unit configuration. The proposed station layout is similar to that at the Pickering site.

The proposed station will be located partly on reclaimed land along the shore south of the CNR tracks, which run through the site, and west of Holt Road, which runs south into the central site area from the MacDonald-Cartier Freeway service road. The units will be aligned in an east-west direction. The arrangement has the nuclear systems of the station and the Vacuum Building facing the lake.

A cooling water intake tunnel will draw water from near the lake bottom approximately 4000 feet offshore and will supply an open intake channel running along the north side of the Powerhouse. Four cooling water pumphouses will be located along the south edge of this channel. Each pumphouse will serve one unit and contain travelling screens, condenser cooling water pumps and service water pumps.

The main group of buildings for the station will be the four Reactor Buildings, a Reactor Auxiliary Bay, a Powerhouse consisting of a Turbine Hall and Turbine Auxiliary Bay, an interconnected Vacuum Building south of the Powerhouse and Administration and Service Buildings at the easterly end of the Powerhouse.

Each Reactor Building serves to support and enclose the reactor and some of its associated equipment and to shield personnel from radiation during operation. The reactor vault forms a part of the containment envelope and serves, in conjunction with the Vacuum Building and connecting pressure relief duct, to contain acitivity which might be released from accidents involving failure of system components.

The Reactor Auxiliary Bay is the area generally surrounding the reactor vault and, in conjunction with the Service Building, provides a continuously accessible area running the full length of the station. It will house the equipment and components of the reactor auxiliaries, the boiler auxiliaries, and the common processes and services for each unit.

The Powerhouse consists of the Turbine Hall and Turbine Auxiliary Bay. The Turbine Hall runs the full length of the building is 180 feet wide. It will house four turbo-generators and some of their auxiliaries. The Turbine Auxiliary Bay also runs the full length of the building and is 60 feet wide. It will house the auxiliary equipment, and its easterly portion, which is in the Service Building, will form a part of the laydown area.

The Service Building, located at the easterly end of the Powerhouse, will serve the entire station. It will contain stores, laboratories and workshops for operations in addition to the station control centre and some of the facilities required for spent fuel storage and treatment and storage of heavy water, spent ion exchange resins and

radioactive wastes. It is expected that a separate Ancillary Services Building, connected to the Service Building by a transfer tunnel, will contain the heavy water upgrading plant as well as off-gases management facilities and additional spent fuel storage.

The Water Treatment Plant and associated demineralized water storage facilities will be located north of the Powerhouse at the intake channel.

The main and unit transformers will be located along the north side of the Powerhouse with the switchyard located between the Powerhouse and the CNR tracks.

In addition to these main facilities, the Darlington site will accommodate construction, storage, parking and security facilities.

4.7 MAIN SYSTEMS

The proposed station will basically consist of four nuclear reactors and auxiliaries, four steam turbine generator sets with associated equipment and station common services. It is presently expected that the four units of Darlington GS A will be similar in design to the nuclear systems of Bruce GS A with modifications to the conventional equipment to accommodate changes in unit capacity.

4.7.1 Reactors

The reactors are the CANDU heavy water moderated, pressurized heavy water cooled, horizontal pressure tube, natural uranium dioxide fuelled type. Each reactor consists of a tubed calandria structure which contains the heavy water moderator/reflector and the fuel channel assemblies. The fuel channel assemblies contain the fuel and the heavy water coolant, and pass through the calandria tubes. The total heavy water requirement for both moderator and heat transport/cooling purposes is approximately 700 tons (short) per unit.

The calandria is supported by end shields which provide part of the building operational shielding as well as full shutdown shielding between the reactor vault and the fuelling machine operating areas. The end shields form part of the steel shield tank in which the calandria is immersed in light water. Neutron-absorbing systems, both liquid and solid are provided to assist in controlling reactivity. Fast reactor shutdown is achieved using shut-off rods or liquid poison injection into the moderator. In-core flux detectors and out-core ion chambers are used in the regulating and protective systems of the reactor.

4.7.2 Fuel and Fuelling System

At the present time, the fuel assemblies for the CANDU reactors are bundles of cylindrical elements made up of compacted and sintered natural dioxide (UO_2) pellets in Zircaloy sheaths. There are approximately 146 tons of UO_2 in the reactor core.

The nuclear characteristics of the CANDU reactor system are such that it is necessary to refuel the reactor while it is operating. To do this, pairs of remotely controlled fuelling machines will service the four reactors. The machines will attach themselves to opposite end fittings of a fuel channel in which the fuel must be replaced. One machine will inject new fuel bundles into one end of the channel in multiples of two, and the other machine will receive the spent fuel bundles pushed out of the opposite end of the channel. The capabilities of the fuelling machines are such that up to 12 bundles of fuel in multiples of two may be replaced per channel at one time.

4.7.3 Steam Supply System

Each reactor is associated with a steam supply system consisting of two independent figure-of-eight loops, incorporating two (or four) boilers (steam generators) per loop with integral preheaters and steam drums.

In the primary heat transport circuit, the pressurized heavy water (D_2O) coolant is pumped through pressure tubes in the reactor to the steam generator. The heat absorbed by the coolant from the fuel in the pressure tubes is transferred to the secondary circuit containing ordinary water (H_2O) in the steam generator. In the steam generator the ordinary water is converted to steam for driving the turbine generator. The heavy water heat transport fluid is pressurized to permit only limited boiling. It circulates in the closed primary system, separated from both the moderator in the reactor core and from the light water in the steam generator.

Following expansion in the turbine, the steam is converted back to water in a condenser, which uses cooling water drawn from the lake. The feedwater is then pumped through low pressure heaters, a deaerating heater and high pressure heater(s), to raise its temperature. It then passes through the steam generator for reconversion to steam.

4.7.4 Turbine Generator System

Each unit steam supply system serves one independent turbine generator system consisting of one, double-flow, high pressure cylinder, followed by moisture separators and steam reheaters, three, double-flow, low pressure cylinders and one electrical generator, plus the associated condensing and feedwater systems.

The combined turbine generator/steam supply system will be of the boiler following type, with the steam supply output and pressure being regulated to meet the turbine steam demand and, in turn, the electrical load on the generator. Exhaust steam from the turbine enters the condenser, from where the condensate is pumped through the feedwater heating system back to the steam supply system.

The turbine generators will be single shaft, tandem compound directly coupled machines with a net rating of 850 MW each, operating at 1,800 rpm. The generators will be rated at approximately 1070 MVA. The stator windings, consisting of hollow copper conductors, will be cooled by low pressure water circulating in a closed loop through a heat exchanger. The rotor of the generator is expected to be cooled by hydrogen at 75 psig pressure. Power produced by the generators will be stepped up to 500 kilovolts at 60 hertz for delivery to the transmission grid.

Monitoring and corrective devices for the protection of the turbine generator unit form important features for the safe operation of the unit. The start-up and synchronization of the turbine will be programmed into the unit computers. This program will monitor turbine conditions, such as bearing vibration and eccentricity, and will initiate corrective action if the permissible limits are exceeded. When a sudden loss of generator load occurs, the governor and speed limiting device prevent excessive speed rise. If the governor fails to operate rapidly enough, the overspeed trip protection will shut the unit down.

4.7.5 Cooling Water System

Water for all purposes including condenser cooling, service water systems, and auxiliary equipment cooling will be drawn from Lake Ontario through an intake tunnel to a common forebay. From the forebay it will be distributed through individual pumphouses to each unit. The intake will be located approximately 4,000 feet offshore at an approximate depth of 40 feet to provide sufficiently cool water for operation during the summer months, and to avoid ice blockage in the winter.

The condenser cooling water (CCW) system will be an open loop type designed to supply approximately 700,000 USgpm to each unit condenser, the total estimated water requirement for all purposes being 3,140,000 USgpm. The intake flow approach velocity will be approximately 1 ft/sec at full load to minimize intake of fish. Water will be returned to the surface of the lake via an open discharge channel. The condensers will be designed for a maximum temperature rise of the cooling water of 19F° at nominal full load. However, short term overload conditions or other contingencies may increase the temperature rise across the station slightly, but the temperature rise will not exceed 20F°. Since the ambient lake temperature at the intake is not likely to exceed 70°F, the maximum discharge temperature is not expected to exceed 90°F. Ontario Hydro is examining means of dealing with lake conditions, such as existed in 1973, which could result in short term discharge temperatures in excess of 90°F with

units operating at full load. Water temperatures in the forebay and discharge channel will be monitored continuously.

Chlorine may be added to the condenser cooling system up to three times a day, depending on water quality and temperature, to prevent the accumulation of biological slimes and entrained materials on the condenser tube surfaces. General practice is to add chlorine in sufficient amounts to satisfy the chlorine demand of the system and to provide a free chlorine residual in each condenser section discharge. The short contact time of 10 to 20 seconds requires on-line chlorine analysis and control to accurately maintain the target residual. Each unit condenser will consist of three separate condenser shells, each with two sections. Each section of each unit condenser would be chlorinated in turn, resulting in a six-fold dilution of the chlorine residual for each unit operating (Section 8.2.2.2). It is anticipated that a free residual of 0.2 mg/l for 45 minutes per unit will ensure condenser cleanliness and protection of aquatic life, based on the available dilution (Section 8.2.2.2). If the study now underway of chlorine residuals in the discharge of several generating stations including Pickering GS A, shows that considerable reaction is available from the unchlorinated water to further reduce the residual, a higher free residual than 0.2 mg/l may be maintained in the condenser, if found more efficient.

4.7.6 Water Treatment System

Water used in the steam cycle must be demineralized and of high quality to prevent corrosion or solids buildup within the closed system. The capacity of the water treatment system, based on the design for Bruce GS A, will be approximately 2300 USgpm of demineralized make-up water. The system will consist of sub-systems for chlorination, clarification, filtration, dechlorination, demineralization, regeneration and storage. The product water quality is expected to be as follows:

Total dissolved solids	-	0.2 ppm as $CaCO_3$
Free and combined CO_2	-	0.1 ppm
Silica	-	0.02 ppm
Specific conductance	-	0.4 micromhos/cm
Dissolved oxygen	-	saturated

The pretreatment system prepares raw lake water for demineralization and will probably consist of chlorination equipment, a chemical feed system, two clarifier-softener and sand filter trains, filtered water sump, four filtered water transfer pumps and three activated carbon filters for dechlorination.

The demineralizing system removes the dissolved ionic impurities present in the filtered water and will consist of three demineralizing trains. Each train likely will have a cation exchanger, a decarbonator, a decarbonator effluent pump and a mixed bed exchanger. The decarbonator is often replaced by an anion bed. The cation exchanger and the cation resin in the mixed bed will be regenerated with sulphuric acid. The anion resin in the mixed bed and in the anion bed, if used, will be regenerated with sodium hydroxide.

The demineralized water will be discharged into two large storage tanks capable of supplying make-up water at steady state conditions (1% make-up per generating unit) for 20 hours without replenishment from the water treatment system. The water treatment system will be designed for continuous unattended operation. In case of air or electrical failure, all devices will fail in the safe position. The system operation and performance will be monitored. Provision will be made to shut down any train if malfunction occurs.

The waste management system for the water treatment plant is described in Section 4.7.7.6.

4.7.7 Waste Management Systems

It is Ontario Hydro's intention to install radioactive waste management systems for the proposed station, which will be designed to meet the targets of 1% of Derived Release Limits (DRL) based on the maximum permissible radiation dose to an individual at the site boundary. Non-radioactive releases will meet regulatory requirements.

4.7.7.1 Site Drainage and Sewage Treatment

The site drainage for the station will generally be conventional, with open ditches and some underground culverts, discharging directly to the lake. Special under drainage systems with sampling connections will be provided for certain areas of the station where contamination of the effluent is possible.

Sewage from all urinals and toilets, washwater from station areas with little or no radioactivity and from all personnel showers except emergency showers, and waste effluent from the cottons laundry will be pumped to a sewage lagoon after analysis for any possible radioactivity. The sewage lagoon system will be designed to handle the peak construction load as well as the long term load associated with operation of the station. Overflow to Lake Ontario is expected to be on a seasonal drawdown basis with batch chemical treatment for phosphate removal prior to drawdown.

4.7.7.2 Radioactive Liquid Wastes

Radioactive liquid effluents from the station will be monitored and sampled. Routine releases will be via the cooling water discharge

channel primarily on a batch basis from collection tanks, following laboratory analysis. Although the regulatory limits for this station require that a permissible discharge concentration, equivalent to the maximum permissible radioactivity level in drinking water, not be exceeded over a monthly averaging period, with instantaneous concentrations of 10 times this level permitted, it is intended that the calculated activity concentration of any given batch after dilution will not normally exceed the regulatory limit. Further, a total activity release limit will be established for the station as a whole for liquid radioactive effluents. This limit will be given in terms of curies per year and will be based on the maximum permissible concentration of various radionuclides in water and the annual average condenser cooling water flow. The design target is that, on an annual basis, the total activity discharged should not exceed 1% of the total activity limit, which is based on the maximum permissible radiation dose to an individual on the site boundary. Achievement of this target may require the use of clean-up techniques which could include filtration, charcoal beds, ion exchange and chemical precipitation systems.

As a further protection, a continuous activity monitor will initiate automatic shut-off of discharge from the collection tanks if a preset activity level is exceeded. As a final routine check on the amount of activity actually released to the lake, a sampling pump will be installed at the cooling water discharge channel outlet. The sewage and service water systems will also have pump sample systems similar to that at the cooling water outlet.

Handling and disposal of potentially active waste liquids will depend on the category of the waste. These are:

(a) Normally Inactive Liquid Wastes

(b) Active Liquid Wastes

(c) Active Chemical Liquid Wastes

Each category of waste will be collected in separate tanks and then processed and/or dispersed on a batch basis.

(i) Normally Inactive Liquid Wastes

This category will consist mainly of shower and washroom drainage discharge and will not normally contain radioactive wastes. However, after collection in dispersal tanks, they will be analysed for activity and diluted if necessary, to achieve permissible release levels prior to being pumped through the station sewage system to the sewage lagoon.

(ii) Active Liquid Wastes

This category will normally consist of low activity liquids. These wastes, which will be drained into collection tanks, could be from decontamination facilities, emergency showers, plastics and cotton laundries, Service Building and Reactor Auxiliary Bay active area floor drains. A separate collection system will be provided for heavy water leakage from main pump seals, heat transport system valves and other equipment. Water in the Spent Fuel Bay is normally in a closed recirculation system, but provision will be made for controlled discharge from the bay to the active liquid waste disposal system.

(iii) Active Chemical Liquid Wastes

This category may consist of liquids of high chemical and/or activity content. Major sources could be from the laboratory and decontamination centres. Collection will be in a designated tank, the contents of which will be mixed and analysed on a regular basis. Provision will be made for chemically neutralizing the waste. Wastes having activities and chemical content less than prescribed levels will be pumped into the category (ii) collection tanks without restrictions. Higher activity liquids, if they occur, will be processed to solid form and stored as required.

4.7.7.3 Radioactive Airborne Effluents

Radioactive airborne effluents from the station will be monitored and filtered, as required, prior to release to the atmosphere. The atmospheric release limits are based on a seven day averaging period and ensure that the maximum permissible annual dose for an individual on the site boundary or for the population beyond the boundary, whichever is the more restrictive, is not exceeded. The design and operating target is that, on an annual basis, the activity released to the atmosphere from the proposed station should not be greater than 1% of the regulatory limit (5 mR/yr) for an individual resident on the boundary of the exclusion area.

There are two distinct groups of potentially radioactive airborne effluents which can be identified. These are managed in different ways.

(a) An off-gases management system will process off-gases from the unit heat transport system bleed condensers, and the spent fuel transfer ports in the Central Service Area, for heavy water removal and decay storage elimination of short lived noble gases, prior to release to the station active exhaust system.

(b) Exhaust air from station areas containing radioactive systems will be monitored and filtered, while exhaust from adjacent areas will be monitored only prior to release to the atmosphere. Filtration provisions for radioiodine removal will be fitted where applicable, e.g., spent fuel storage bay exhaust, fuelling machine

maintenance areas and Reactor Building exhaust. In areas where there is a significant continuous activity release to the building atmosphere, closed ventilation systems which recirculate the air will be used. These systems will include provisions for purging. The exhaust monitoring systems will consist of iodine, particulate and noble gas monitors and a tritium sampler for each exhaust route. Dampers in containment exhaust ducts will close on indication of high gross beta/gamma activity. Monitors will not be installed on the exhausts from the Turbine Hall or Turbine Auxiliary Bay since they contain no active systems and should not normally be subject to cross-contamination.

4.7.7.4 Radioactive Solid Wastes

The storage method for various solid wastes will depend on the nature of the waste. Filters, ion exchange resins and various other wastes will be stored in waste management facilities both at the station and later at a central waste management area operated by Ontario Hydro. Spent fuel will be stored under water in on-site spent fuel bays which will have sufficient storage capacity for several reactor-years accumulation of spent fuel. At some time in the future, spent fuel will be transferred off-site to a central storage area.

Management of solid radioactive wastes in all cases will include provisions for retrieval at some future date.

4.7.7.5 Transportation of Radioactive Material

The transportation of radioactive waste material from the proposed station to the waste management area will be according to stringent regulations governing radioactive shipments in Canada. The probability of significant leakage of radioactive wastes from approved containers, in the unlikely event of a transport accident, fire, etc., is very low due to the stringent requirements regarding containers and flasks utilized for radioactive waste transport.

4.7.7.6 Miscellaneous Waste Treatment Systems

(i) Water Treatment Plant Wastes

The clarifier-softener blowdown will be routed by gravity through a settling basin. After settling has taken place, the liquid will overflow to the neutralizing sump where samples are taken for chemical and radioactivity analysis. Retention time in the settling basin will be at least two to three days. The basin will be emptied every few years when the settled volume builds up, at which time approval for the disposal of the solids will be obtained from the Waste Management Branch of the Ministry of the Environment. During the period of several weeks when the settling basin is being emptied, it may be necessary to by-pass the basin and discharge the clarifier-softener blowdown directly to the neutralizing sump.

A neutralizing sump serves to collect the backwash water from the filters and activated carbon purifiers and regenerant solutions from the water treatment plant ion exchangers. Neutralizing sump contents will be monitored for pH before discharge to the condenser cooling water. A neutralizing agent will be added such that the sump effluent pH will be within the range 5.5 to 9.5 and the pH of the total station discharge will be within 0.5 units of the natural lake pH.

(ii) Boiler Blowdown

Recent studies indicate that continuous congruent phosphate chemistry control of boiler water, as originally proposed, may cause corrosion of the boiler tube materials used for Bruce GS A and B. It is now proposed to use volatile amines and hydrazine for normal chemistry control.

In the event of a condenser tube leak, temporary low level phosphate treatment (less than 10 ppm) may be required until the leaking condenser is fixed or isolated, after which the system would be returned to normal volatile chemistry control.

(iii) Oil Contaminated Drains

A system is to be developed for routing oil contaminated drains to a central treatment area. The oil will be recovered and the clean water then discharged to the lake via the normal drainage system. A collection and separation system for any acute (fire spill) and normal oil leakage from the transformers adjacent to the powerhouse is being developed. There will be no drainage from askarel-filled transformers.

(iv) Intake Screening and Trash Disposal

Each unit cooling water supply channel will be fitted with a coarse bar screen to remove gross debris. Each unit will have a screen well with travelling screens which will be washed on a time cycle or on demand. Debris will be washed into trash baskets, and the contents disposed of on site.

4.7.8 Heavy Water Upgrading Plant

Heavy water which leaks out of the nuclear systems will be collected and upgraded by a process which involves clean-up and removal of any ordinary water. The heavy water upgrading plant will consist of two trains of distillation towers operating under vacuum, a system to maintain vacuum on the towers and tankage for feed and product storage. Downgraded water may be fed into one of several points on the towers such that the isotopic concentration corresponds closely to the concentration profile in the distillation towers. Reactor grade water, 99.8% weight D_2O, is withdrawn from the bottom of the last tower in the train and passed through the product evaporator for final

purification. Overhead distillate from the top of the first tower in the train contains less than 1% by weight D_2O and is split into the reflux stream which is returned to the tower, and the tails or reject stream which is mixed with the cooling water and discharged to the lake.

4.7.9 Transmission System

The transmission required to incorporate the Darlington site development into the grid will depend upon the location of the main 500 kV east-west transmission corridor which will link Lennox GS near Kingston, and Wesleyville GS near Port Hope with a proposed Oshawa Area Transformer Station (TS).

The route of the Lennox-Oshawa transmission is the subject of public inquiry, now underway, by the Solandt Commission. The task of the Solandt Commission, which was previously appointed by the Province of Ontario to conduct an inquiry into the routing of the Nanticoke-Pickering transmission corridor, has been expanded to include inquiry into the alternative routing of the Lennox-Oshawa lines (139).

4.8 AMENITIES AND PUBLIC FACILITIES

Studies to date on plans for landscaping and site enhancement include a concept for a warm water beach and associated park areas (Section 9.3). The topography of the Darlington site provides a natural screen of the proposed station yard from the community of Bowmanville to the northeast or from the MacDonald-Cartier Freeway to the north.

Trees and other vegetation will be left in their natural state wherever possible. The topsoil which is removed from the areas to be graded for the proposed station and associated facilities will likely be used for later landscaping purposes.

The topography of the existing site shoreline does not lend itself to intensive cottaging or swimming. However, with the proposed site layout, the 600 acres of land north of the CNR tracks and south of the service road will undergo little clearing or grading. Ontario Hydro is carrying out a study to determine the possibility of developing this and other site areas for public usage.

4.9 FINANCIAL ASSISTANCE TO COMMUNITIES

4.9.1 Grant-In-Lieu Payments

Under the terms of the Power Corporation Act of Ontario (formerly Power Commission Act), Ontario Hydro pays a grant-in-lieu of taxes on all its property and buildings required for the generation of electric power. These yearly payments are made to the local municipality based on the assessed values of the land and administration buildings and of

the plant and service facilities. The latter is payable when units are operational on a per unit basis. The local municipality (in this case, the recently established Town of Newcastle) then passes on to the county level (in this case, the new Regional Municipality of Durham) only a portion of those payments directly attributable to county levies. Under the terms of the above Act, the local municipality must retain those funds normally passed on to the county for education purposes.

In 1974, the total grant-in-lieu of taxes paid by Ontario Hydro for the Darlington site was $10,900. Based on the Town of Newcastle's 1974 mill rates, this amount will increase to about $56,000 in 1983 (year after the first generating unit is to be placed in service) and to about $175,000 in 1986 (year after the fourth unit is to be placed in service). It is not anticipated that the grant will be affected by a limitation to 50 percent of the Town's total tax levy, as imposed by the above Act.

4.10 CONSTRUCTION

4.10.1 Site Access

Construction traffic from the MacDonald-Cartier Freeway will use either Interchange 73, Courtice Road (Durham Regional Road 3), to the west of the site or Interchange 74, Waverly Road, to the east. Traffic will then proceed from these interchanges along the service road, which is located south of and parallel to the MacDonald-Cartier Freeway, to Holt Road, the main access road to the site. Subsequent to continuing studies for quantities of materials to be transported by road and their sources, appropriate approval will be sought from the Ministry of Transportation and Communications regarding the use of the access interchanges. Agreement has been made for Ontario Hydro to maintain the service road. Holt Road will be rebuilt to two lanes to accommodate the construction traffic. Temporary Bailey bridges will span the CNR tracks during the construction phase and will be replaced by a permanent structure at a later time.

A railway spur line will be constructed to connect with the CNR line that bisects the Darlington site. This line will run west from the east boundary parallel to and south of the CNR tracks to the powerhouse area.

4.10.2 Site Clearing

Most of the original forest cover in the area has been removed and the land converted to general farming and dairying. Within the site boundaries the only trees remaining are found along lot boundaries, road allowances and in a few small clusters dotting the site. Sugar maple and beech are the common trees found in the area, with elm found in slightly poorer drained locations. There are also two orchards, mostly apples, located on the west half of the site near the powerhouse yard excavation. Except for these orchards there will be

little site clearing required, and efforts will be made wherever possible to save the remaining trees and shrubs within the site.

4.10.3 Site Grading and Shoreline Reclamation

The mean ground surface elevation in the site area south of the CNR tracks is at about El. 300. The proposed grade for the powerhouse yard is at El. 256, and that for the switchyard is at El. 320. This means that a sizeable excavation operation will be required to bring the ground to the proposed grades. In the switchyard area, the topsoil and the glacio-lacustrine silts and clays will be removed and the area backfilled to El. 320 with suitable materials from the main excavation in the powerhouse yard area. In the powerhouse yard area, aside from the complete removal of the topsoil and the glacio-lacustrine silts and clays, most of the upper till material and part of the interglacial sands and silts will also be excavated. Of the total materials excavated from the switchyard and the powerhouse yard areas, the topsoil and glacio-lacustrine soils are considered unsuitable for use as backfill material. However, these soils will be stockpiled for later use in landscaping and in the construction of scenic mounds.

Due to the relatively small area of the Darlington site, the geographical restrictions and the bisection of the site by the CNR tracks, Ontario Hydro proposes to reclaim approximately 120 acres of land along the shoreline of the western half of the site. This development is illustrated in Figure 4-5. The new shoreline will be approximately 6000 feet long and will extend approximately 1200 feet offshore into water 15 to 20 feet deep.

To develop the western half of the site, the area to be occupied by the proposed station, and any future Darlington GS B station, Ontario Hydro proposes to first construct a rockfilled cofferdam to enclose the area. A cut-off trench would be required along the entire length of the cofferdam. This will provide a positive seal against the ingress of water beneath the cofferdam, through the lake bottom permeable layer, during the dewatering process. The cofferdam will consist of a rockfilled core with a coarse rock bedding. Armour stone will protect the lakeside face above the waterline against wave action erosion. A double filter layer, two layers of materials of different coarseness, on the landside of the cofferdam will be followed by an impermeable till seal. The total quantity of material needed for construction of this rockfilled cofferdam is estimated to be 888,500 cubic yards (38).

Once the cofferdam is completed the enclosed area can be dewatered. Backfilling and compacting of the area can proceed after the dewatering process is completed. The backfill material will be obtained from that material excavated from the site to bring the powerhouse and switchyard areas to their proper grade levels.

To meet critical target dates, construction of the rockfilled cofferdam should begin in June, 1976. The cofferdam should be completed by mid 1977. Dewatering, backfilling and compacting can then proceed to permit the first concrete to be poured for the powerhouse foundation by April of 1978.

5.0 LEGAL REQUIREMENTS

5.1 RADIATION EXPOSURE REGULATIONS

The Atomic Energy Control Board (AECB), a federal agency, was created in 1946 by the Atomic Energy Control Act as the regulatory agency for atomic energy in Canada. The AECB reference dose limits for exposure of the public have been outlined (1, 2, 3, 46). These limits are based on recommendations by the International Commission on Radiological Protection (ICRP).

At the provincial level, "radiation" is one of the contaminants whose release may be subject to provincial review as outlined in the amended Environmental Protection Act, 1971, (Ontario) (4). However, there is no direct authority at the provincial level for regulating, restricting or prohibiting the installation, use, handling, maintenance, storage or disposal of potential sources of radiation.

At the international level, the International Joint Commission (IJC) refers to radioactive materials as a possible pollutant (5).

The radiation dose limits for members of the public, as set by the AECB and recommended by the ICRP, are given in Table 5.1.

TABLE 5.1

RADIATION DOSE LIMITS

Organ	Annual Dose Limits (rem)
Whole-Body, Gonads, Red Bone Marrow	0.5
Skin, Bone, Thyroid	3.0*
Other Single Organs	1.5
Extremities	7.5

*The dose to the thyroid of a person under the age of 16 years shall not exceed 1.5 rem/year.

These limits apply to the combined total of normal plus abnormal releases from an operating nuclear station. "Abnormal" refers to releases arising from single failures in the essential process equipment. The frequency of failures in the essential process equipment that would result in a significant release of fission products from the equipment if the protective devices fail to operate, should not exceed once in three years (2).

The AECB further limits the population dose to:

(i) 10^4 man-rem per year to the whole body

and (ii) 10^4 thyroid-rem per year per site.

For gaseous radioactive releases, the integration of population dose extends over all areas outside the exclusion area in which the external individual dose exceeds 5 millirem/year, or the individual thyroid dose exceeds 30 millirem/year, or the areas out to 10 miles, whichever is greater. The exclusion area is the area around a station which is within approximately one kilometer (3,000 feet) of the nearest reactor building.

The dose limits set by the AECB are not regarded as design targets but are regarded as maximum limits which must not be exceeded. The ICRP recommendation that all exposures be kept as low as practicable (6) is supported by the nuclear industry in Canada.

5.2 AIR QUALITY

5.2.1 Federal (Radiological)

The amount of radioactive airborne material that may be released from a nuclear station to the atmosphere is governed by the maximum dose limits set out by the AECB (see Section 5.1). It is necessary to convert these limits, which are given in rem, to some other basis which will be more useful to the station designer and operator. Following AECB and ICRP recommendations (7, 8), dose conversion factors have been produced which relate dose limits in rem to maximum permissible concentrations in air (MPC_a) for continuous exposure. The dose conversion factors take into account various factors such as most susceptible individual organs, method of uptake, etc. In Table 5.2, which lists MPC_a, a critical uptake pathway is through the food chain. Children, who drink large quantities of milk, are the limiting group for the concentration of several radio-isotopes in the air over farm land.

TABLE 5.2

MAXIMUM PERMISSIBLE CONCENTRATION IN AIR (MPC_a) FOR CONTINUOUS INTAKE

Radionuclide	External Irradiation $\frac{\gamma Ci\text{-}MeV}{m^3}$	Inhalation	Food Chain (Milk)
		Ci/m^3	
(1) Noble Gases	6.4×10^{-8}		
(2) I-131		3×10^{-11}****	6×10^{-13}*******
(3) H-3		3×10^{-7}	
(4) Particulates:			
Cs-137		1.5×10^{-9}	5×10^{-11}
Cs-134		1×10^{-9}	1.5×10^{-11}
Sr-90		4×10^{-11}	1.5×10^{-12}
Sr-89		2×10^{-10}	1.5×10^{-11}
Co-60		9×10^{-11}	
Ru-106		4×10^{-11}	
Unidentified** Particulates		4×10^{-11}	1.5×10^{-12}

* Assumes 50% of the dose is from the shorter-lived radioiodines accompanying I-131.

** The lowest MPC_a value under 'particulates' is used as the MPC_a for unidentified particulates. Measurement of unidentified particulate activity in the stack effluent will be based on the counting efficiency for Cs-137.

*** Based on a dose to a child's thyroid of 1.5 rem/year.

**** Assumes open field grazing 6 months per year.

The figures in Table 5.2 are based on the assumption that only one isotope is present at any one time; if several isotopes are present, their combined effect must be considered. Similarly, there may be other sources of radioactivity such as drinking water, edible fish, etc., that may contribute to the overall dose received. In addition, the MPC apply beyond the site boundary regardless of the number of radioactive waste emitting installations located there. More extensive information is given elsewhere (9). It must be emphasized that the above values represent the legal maximum permissible concentrations of radionuclides in respirable air available to the public on a continuous basis.

For design purposes, the MPC_a must be converted to Derived Release Limits (DRL). The DRL have units of curies per unit time and they are the best estimate of the maximum permissible average release rates if compliance with the maximum permissible dose limits for the public is to be ensured. The basis for the derived release limits for both airborne and liquid effluents from Ontario Hydro nuclear generating stations during normal operation takes into account the total release resulting from continuous, low level releases; from controlled, short-term releases; and from short-term releases resulting from any routine failures of process equipment (9). The following formula indicates the relationship between DRL during normal operation and the maximum permissible concentrations of radionuclides in air available to the public:

$$C = KQ$$

where: Q is the release rate (Ci/sec)

C is the concentration at a given distance from the source (Ci/m^3)

K is the dilution factor (sec/m^3)

The dilution factor K is a function of the distance from the source, the effective height of release, the weather, and the averaging time i.e., the time over which it is measured. Methods of estimating effective stack height and atmospheric dilution, taking into account atmospheric stability, have been developed by the U.K. Atomic Energy Authority (10). The averaging time adopted by Ontario Hydro for calculating permissible release rates is one week.

5.2.2 Federal (Non-Radiological)

The Federal Department of the Environment is responsible for enforcing regulations under the Clean Air Act, 1971, relating to ambient air quality and control of air pollution in Canada. The Act, limited in scope by the provisions of the British North America Act, is designed to assist provincial agencies in maintaining desirable ambient air quality.

5.2.3 Provincial

The provincial Ministry of the Environment is responsible for enforcing regulations under the Environmental Protection Act, 1971, to attain desirable air quality in the province.

The operation of a power generating station must meet legal requirements regarding atmospheric emissions. Legal requirements for radioactivity emissions at the Darlington site are promulgated at the federal level. However, the fossil fuelled combustion turbines for the standby generators do emit air pollutants which come under provincial jurisdiction. These requirements may include any or all of the following as defined under the Environmental Protection Act, 1971, by the Air Pollution Control Act, 1967, and its amendments.

(a) Standards for concentrations of air contaminants at point of impingement.

(b) Criteria for ambient air quality.

(c) Regulations on plume opacity.

(d) Regulations to prevent discomfort to persons, loss of enjoyment of normal use of property, interference with normal conduct of business or damage to property.

Incinerators are also regulated by the ministry and must be operated in an approved manner with any control equipment deemed necessary by the agency.

Desirable levels of certain contaminants have been set out in the legislation as criteria for ambient air quality. Impingement levels of contaminants emitted from sources are also set out in the regulations so as to achieve and maintain these ambient levels.

5.2.4 International

Canada and the United States, through the International Joint Commission, confer on transboundary emissions. This commission has no power of enforcement, but makes recommendations where international boundary problems exist.

5.3 WATER QUALITY

5.3.1 Federal Regulations

5.3.1.1 Radiological

The amount of radioactive liquid material that may be released from a nuclear station to a water body is governed by the maximum dose limits set out by the AECB (Section 5.1). The two main exposure pathways to man are by drinking water and consuming fish containing various radionuclides.

Quantity limits on a yearly basis for each radionuclide from all streams will be established for the station as a whole and will be determined as the product of the maximum permissible concentration of the radionuclide in the cooling water flow and the annual average cooling water flow, specified in the operating license. This quantity limit will become the station Derived Release Limit upon which the design target of 1% DRL will be based.

Maximum permissible concentrations of radionuclides in the station discharge have been specified based on the legal dose limits. Various factors such as the most critical group, uptake mechanisms, probable consumption, etc., have been taken into account in relating dose limits to MPC (11). Table 5.3 indicates the maximum permissible concentrations of radionuclides in water available to, or accessible by the public.

TABLE 5.3

MAXIMUM PERMISSIBLE CONCENTRATIONS IN WATERS AVAILABLE TO THE PUBLIC

Radionuclide	MPDI (μCi/day)	MPC_w* (μCi/ml)	MPC_{fw} (μCi/ml)
I-131	2.6×10^{-4}	3×10^{-7}	3×10^{-7}
H-3	4.5	5.5×10^{-3}	5.5×10^{-3}
Cs-137	2.2×10^{-2}	1×10^{-5}	4×10^{-7}
Cs-134	1.4×10^{-2}	6×10^{-6}	3×10^{-7}
Sr-90	8.8×10^{-4}	4×10^{-7}	3×10^{-7}
Sr-89	1.8×10^{-3}	2×10^{-6}	2×10^{-6}
Co-60	0.11	5×10^{-5}	1.5×10^{-5}
Ba-La-140	4.4×10^{-2}	2×10^{-5}	6×10^{-6}
Ru-106	2.2×10^{-2}	1×10^{-5}	3×10^{-6}
Zr-Nb-95	0.13	6×10^{-5}	8×10^{-6}
Xe-144	2.2×10^{-2}	1×10^{-5}	3×10^{-6}
Zn-65	0.22	1×10^{-4}	3×10^{-6}
Fe-59	0.13	6×10^{-5}	2.5×10^{-6}

* Critical group for I-131, H-3, and radiostrontium is the infant; critical pathway is drinking water (I-131 limit based on a dose of 1.5 rem/year to child's thyroid).

MPDI - maximum permissible daily intake

MPC_w - maximum permissible concentration in water used only for drinking

MPC_{fw} - maximum permissible concentration in water used for drinking and from which fish are caught for human consumption.

The average radionuclide concentrations in the station effluent on a monthly basis should not exceed the MPC_{fw} given in Table 5.3. Short-term concentrations averaged over a short period should not exceed ten times these values. For cases where several unidentified radionuclides are released, the MPC_{fw} for the most restrictive radionuclides, 3×10^{-7} µCi/ml, will be used as the average effluent MPC_{fw} for gross beta-gamma activity.

It must be noted that for the situation where an individual lives near a nuclear station he may receive a small radiation dose from a number of sources, e.g., inhalation, food consumption, drinking water. In this case, the total dose received must be less than the legal limit specified by the AECB.

5.3.1.2 Non-Radiological

The federal government may enact legislation on discharges to water and resulting water quality by virtue of its responsiblity for international and interprovincial waters and fisheries. The Canada Water Act, 1970, provides for the establishment and operation of federal - provincial water quality management areas. The Act prohibits the disposal of waste, including heat, into water in any given management area except in quantities under conditions prescribed by the regulations. However, no regulations concerning thermal discharges have been made under the Act.

A 1970 amendment to the Fisheries Act, 1952, prohibits the deposition of any wastes in waters, including heat, which will degrade the water quality. Under this Act, the Department of Fisheries and Forestry may enquire into a company's plans for expansion and can demand modifications to its anti-pollution measures if considered necessary to protect the fisheries waters.

Disposal of dredgings in the lake falls under the provisions of the Navigable Waters Protection Act, 1970, which is enforced by the federal Ministry of Transport. An application by Ontario Hydro to dredge and dump will be referred back to the Ontario Ministry of the Environment and the Ministry of Natural Resources to determine if the proposed dumping procedure will have any adverse environmental effect. Depending on the assessment by these two provincial ministries, the Ministry of Transport may then issue a license to dredge and dump.

5.3.2 Provincial Regulations

The main body of provincial legislation for controlling discharges to water and the resulting water quality and biological effects is contained in the Ontario Water Resources Act. This Act gives the Ministry of the Environment the authority to supervise all surface and ground waters in Ontario. With respect to discharges, Section 30 states:

"Under sections 31, 32, 34 and 36, the quality of water shall be deemed impaired if, notwithstanding that the quality of the water is not or may not become impaired, the material deposited or discharged or caused or permitted to be deposited or discharged or any derivative of such material causes or may cause injury to any person, animal, bird or other living thing as a result of the use or consumption of any plant, fish or other living matter or thing in the water or in the soil in contact with the water."

The Ministry of the Environment outlines its criteria in the publication - "Guidelines and Criteria for Water Quality Management in Ontario". These guidelines and criteria do not have force of law, but there are legal procedures under the Act for enforcing compliance. In addition to adhering to these objectives, Ontario Hydro will consult with the Ministry of the Environment and submit applications for permits or approval for specific aspects of the proposed project which may have water quality implications. These include:

(a) The maximum allowable temperature rise between intake and discharge in the condenser cooling water. It is recognized that the Ministry of Environment guidelines require that this temperature difference at the proposed station should not exceed 20F^{o} and that the exit temperature of the discharge water should not exceed 90^{o}F.

(b) The volume of cooling water to be used including that used for any tempering.

(c) A prediction of the area of the receiving body to be occupied by the heated discharge under various climatological conditions.

(c) Emissions to water with respect to possible biological changes or influences.

(e) Miscellaneous discharges, e.g., from the water treatment plant, boiler blowdown and site drainage.

(f) Water quality during dredging and dumping operations.

(g) Batch releases of boiler treatment chemicals during the commissioning period.

Contingency planning, for inadvertent discharges or spills, will be provided for in the environmental project requirements and will be based on the Ontario Hydro Management Guide No. M-19-0, Ontario Water Pollution Legislation Guidelines for Conformity, February 1974.

The Ministry of Natural Resources can enforce the Lakes and Rivers Improvement Act and some provisions of the federal Fisheries Act within the province. In practice, there is consultation between the Ministry of the Environment and the Ministry of Natural Resources, both of which have concern over the effects of discharges to the aquatic environment.

5.3.3 International

5.3.3.1 International Joint Commission - Radioactivity

The International Joint Commission (IJC) is a body which investigates, recommends and attempts to coordinate monitoring and surveillance activities on the quality of the boundary waters shared by the United States and Canada. The IJC discharges its function under the Boundary Waters Treaty of 1909. Proposals for specific objectives regarding radioactivity levels in receiving waters have been made (12). Ontario Hydro effluent radioactivity levels will conform to these proposals once they are ratified.

5.3.3.2 International Joint Commission - Conventional Water Quality

Proposals for water quality objectives were issued in 1970 by the International Joint Commission (IJC), for Lake Erie, Lake Ontario, the International Section of the St. Lawrence River and the connecting channels of the lower Great Lakes. In these proposals, the objective is that no heat discharge should be allowed which would adversely affect any local or general use of these waters. The IJC recommended that its programs and measures to achieve its objectives be agreed to by the Governments of Canada and the United States. It also recommended that appropriate government agencies be involved in site selection and consulted in the design of thermal plants in order to minimize any adverse effects of temperature changes in the receiving waters. The IJC further suggested an extension of its existing authority to promote the implementation of its objectives.

There has been recent formal agreement between the Governments of Canada and the United States to give force of law to certain IJC proposals.

5.4 SOLID WASTES

5.4.1 Radioactive Solid Wastes

The Atomic Energy Control Act contains regulations which govern the safe handling and transportation of radioactive materials, but there are no specific regulations governing the management of radioactive waste, although waste management practices have been reviewed and authorized by the AECB. Ontario Hydro has developed a set of waste management regulations for inclusion in the Ontario Hydro Radiation

Protection Regulations. The basic philosophy of the regulations is summarized by the first of the waste management principles, namely:

> "All radioactive wastes shall be managed such that the public, its environment, and its resources are protected against hazard".

Further principles regarding radioactive waste storage are:

> "Facilities intended for storage of radioactive waste shall be designed to prevent radionuclide releases to the environment", and "Radiation exposure to individual members of the public resulting from the operation of the waste management facility shall not exceed ... (the maximum dose limit specified by the AECB in Table 5.1)".

Once a suitable site for a radioactive waste management area has been found, and before any construction can begin, plans for the site and facility must be submitted to the AECB for its approval. When the AECB is satisfied that the site is suitable and that all appropriate measures have been taken to ensure that the general public and the environment are adequately protected, a construction permit will be issued. In order to operate the facility, the applicant must obtain an operating licence which is renewable at regular intervals provided satisfactory operating standards and environmental monitoring are maintained. The AECB has recently issued a guide for licensing of radioactive waste management facilities (43).

5.4.2 Non-Radioactive Solid Wastes

Collecting, transporting, processing and disposal of solid wastes during construction and operation are controlled by the provisions of the Environmental Protection Act, 1971. The two types of Certificates of Approval issued by the Ministry of the Environment are for Waste Management Systems and Waste Disposal Sites.

A Waste Management System Certificate of Approval is required for collecting and transporting of wastes. This Certificate of Approval is not required if Ontario Hydro uses its own vehicles on the property, but is required if public roads or if rented property is used. If handling is carried out by a contractor, he must take out the Certificate of Approval.

A Waste Disposal Site Certificate of Approval is required for each property where there is a disposal site. Waste from trash racks, on-site ash disposal and sewage lagoon residues require a Waste Disposal Site Certificate of Approval. For off-site disposal, site approval and a Waste Management System Certificate of Approval are also required. Oil disposal on roads requires a Waste Management System Certificate of Approval and the locations of intended disposal areas need to be stated.

Expansion of a system or site requires further application and hearings. The Certificates of Approval for a Waste Disposal Site or a Waste Management System expire one year after the approval date and must then be renewed.

Floating material removed by the travelling screens should not be returned to the water body but should be disposed of at an approved location. The Ministry of the Environment provides a water-use permit based on this requirement. In addition, under the provisions of the Environmental Protection Act, disposal of trash rack material must have a Certificate of Approval for the particular solid waste disposal system to be used. However, under the federal Fisheries Act, the provincial Ministry of Natural Resources is empowered to investigate cases where fish are removed from the water body, the Ministry's main concern being that fish should be returned in an unharmed condition.

5.5 NOISE

Noise originating from industrial and other sources and emanating to the surrounding community is presently receiving attention at the federal and provincial government levels. With the exception of municipal by-laws in some areas, legislation governing the noise levels at the industry-community property line are non-existent. One municipal by-law requires the noise levels not to exceed 45 dbA at the property line.

Although there is no unanimous agreement on the permissible noise levels at the industry-community property line, it is most probable that the upper limit, as set by the future legislation, would be below 40 dbA on a continuous noise basis and 50 dbA on an intermittent noise basis.

5.6 LAND USE ZONING

5.6.1 Site Area

The entire Darlington site, of which some parcels are still in the process of being acquired by Ontario Hydro, will ultimately contain about 1400 acres. Included are approximately 200 acres to be purchased in Lake Ontario waterlots, about 120 acres to be reclaimed.

The site is located within the former Township of Darlington. Proposed Amendment No.8 to the Official Plan of the Darlington Planning Area, adopted by the Council of the former Township of Darlington in November, 1973, is presently still before the Ministry of Housing for approval. This proposed Amendment designates the Darlington site for industrial use (Figure 5-1).

By-Law No. 2111 of the former Township of Darlington, as amended and still in effect, designates almost half of the area within the Darlington site for industrial use with the remainder allocated for

agricultural use. However, under the terms of the By-Law, these designations do not apply to the use of the land by Ontario Hydro.

5.6.2 Transmission System

The property for the transmission lines of the proposed station will be purchased or leased. The right-of-way may be used for agriculture or any other purpose compatible with the transmission right-of-way and local zoning bylaws.

5.7 PROJECT APPROVAL PROCEDURE

To obtain approval for the location of a proposed generating station on a particular site, Ontario Hydro must satisfy the provincial regulatory authorities regarding its environmental suitability. Data relating to all environmental considerations for a given project is compiled in an Environmental Assessment, which describes the existing environment at the site and the possible and expected environmental effects and community impact of both construction and normal operation of the proposed station. The Environmental Assessment is presented to the Minister of Energy who distributes it to the various ministries for comment. It is also made available to the public prior to public participation meetings where matters of concern or interest relating to the proposed station may be discussed. These matters are recognized to be the economic and social impacts of the project on the community, the recreational or industrial uses of lands and waters adjacent to the station, the operating and potential accidental releases of harmful substances to the environment and the aesthetic and other environmental effects of the project. These views and comments, where appropriate, in addition to those of the various Provincial Ministries will be incorporated in a Final Proposal for submission to the Minister of Energy for approval of the proposed project.

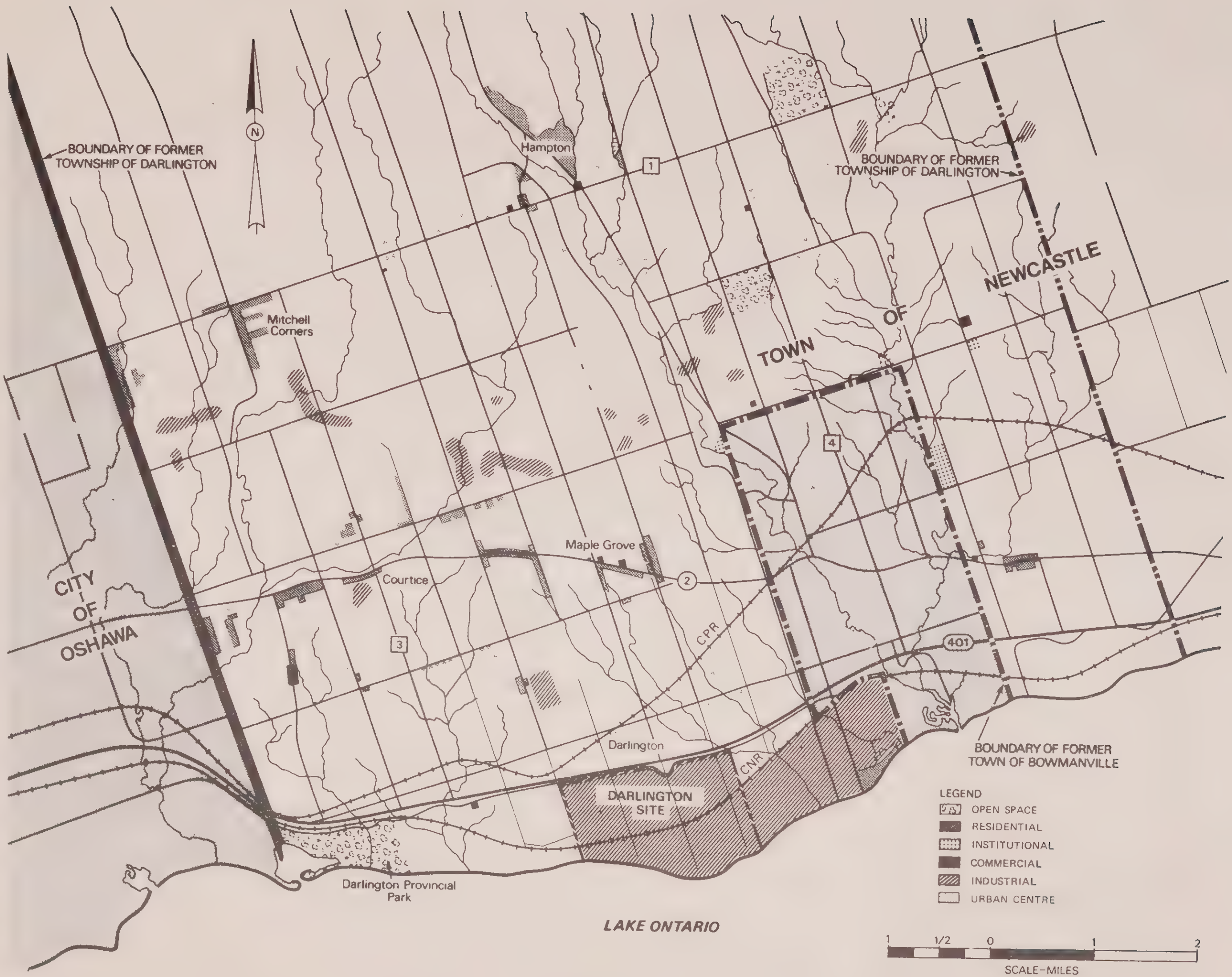


FIGURE 5–1 PRESENT LAND USE – DESIGNATED

6.0 EXISTING ENVIRONMENT

6.1 AIR

6.1.1 Quality

6.1.1.1 Radiological

Background external gamma radiation has been measured by Ontario Hydro at the Bruce Nuclear Power Development (BNPD) and at the Pickering sites. The level of background radiation is influenced by several factors such as geographic location, elevation and the time of year. Background radiation can vary as high as 150 millirem/year but at both the BNPD and Pickering sites the background radiation averages about 50 to 70 millirem/year with a natural variation of up to 10 to 20 millirem/year. The natural background gamma radiation at the Darlington site is not expected to be significantly different from these values.

Ontario Hydro plans to institute a comprehensive radiological monitoring program at the Darlington site in 1975 but until such time, no other pertinent radiological data for the site are available.

6.1.1.2 Non-Radiological

Air quality data are not available for the immediate area of the station, however, since the area is mainly rural, it is expected to be good. At the Wesleyville site 15 miles east, air quality has been monitored over a period of months and has been found to be good.

The St. Mary's Cement Plant, adjacent to the site, is the nearest industrial source of atmospheric emissions. The community of Bowmanville and the City of Oshawa, at three miles and six miles respectively, are the closest urban areas. Atmospheric emissions from these areas will have only a small effect on air quality in the immediate area of the site.

6.1.2 Meteorology

6.1.2.1 Climatology

Due to its shoreline location, the site will experience mesoscale variations in synoptic weather conditions. These include lake breeze effects and slight tempering of the wide air temperature range experienced inland. Climatological data are available from four observing stations: Toronto International Airport, Trenton Airport, Toronto Island Airport and Cobourg. The first two are first order climatological stations.

(i) Air Temperature

The severity of the temperature change with season is slightly tempered by the proximity to a large fresh water body. The air temperatures are generally cooler in summer and milder in winter than in areas further inland. In July, the mean daily range inland is 22-26F^{o} compared to 18-20F^{o} along the shoreline (13). The mean annual frost-free period is 160 days at the site, compared to 130 days approximately 40 miles inland.

Table 6.1 gives air temperature normals for Toronto Island Airport; these are considered sufficiently representative for use at the Bowmanville site.

(ii) Precipitation

The mean annual precipitation for the site is 32 inches, this is accounted for by 25.6 inches of rainfall and 64 inches of snowfall (13).

Annual evaporation is estimated at 30 inches (14). This rate is based on class A, evaporation pan data, used in the equation of Kohler et al, 1955 (15).

TABLE 6.1

TEMPERATURE NORMALS FOR TORONTO ISLAND AIRPORT, °F

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Temp	24.6	24.9	31.4	42.3	53.5	62.9	69.1	68.3	60.8	49.5	39.0	28.5	46.2
Ave. Max Temp	30.3	30.8	37.3	48.6	63.4	71.4	77.3	76.1	68.3	56.2	44.6	33.7	53.2
Ave. Min Temp	18.8	19.0	25.4	36.0	43.5	54.3	60.8	60.5	53.3	42.7	33.4	23.2	39.2

Highest Recorded Temperature 94
Lowest Recorded Temperature -12

6.1.2.2 Wind

Wind data have been collected for the past four years at the Wesleyville site (40), approximately 15 miles east along the shoreline. These data are representative of conditions at the Darlington site. Longer term data are available from more distant locations such as Toronto International Airport (41) and Trenton Airport (41). Data for wind direction and velocity for these three sites are summarized in Tables 6.2 and 6.3. Although all three locations show similar characteristics, the Wesleyville and Trenton data indicate few off-lake winds from the general south and southeasterly directions.

Figure 6-1 shows a wind rose for the site based on four years of record at Wesleyville. Winds are towards the land areas approximately 35% of the year. This frequency is expected to apply to the Darlington site.

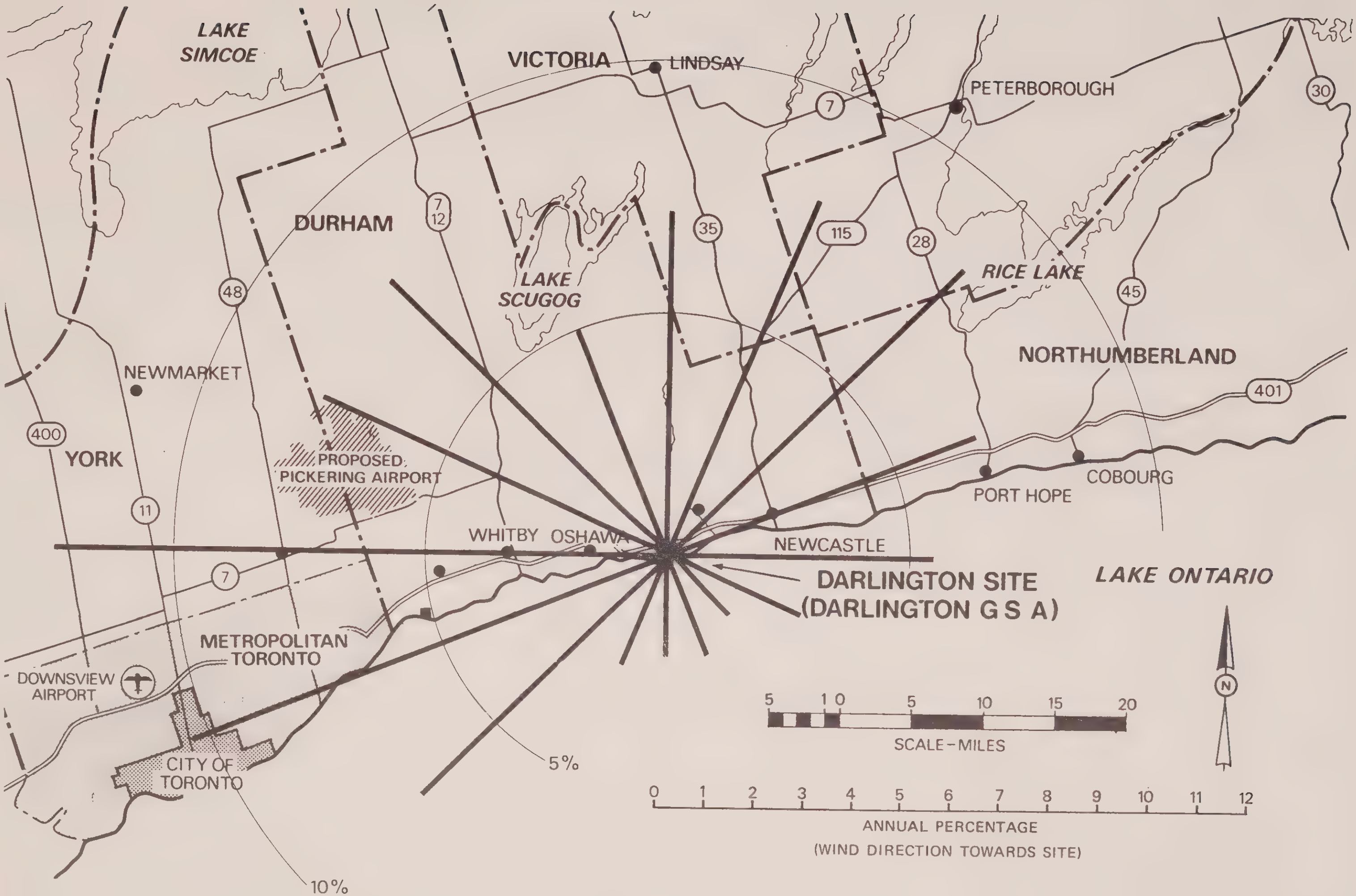


FIGURE 6–1 ANNUAL WIND DISTRIBUTION–FREQUENCY PERCENTAGE

TABLE 6.2

WIND DIRECTION - ANNUAL FREQUENCIES (PERCENT)

Location	Sampling Period	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
Wesleyville Site	1970-74	7	8	8	7	5	3	2	2	2	3	7	11	13	8	8	5	1
Toronto International Airport	1955-66	12	3	3	3	4	2	4	4	6	5	9	7	11	7	7	8	5
Trenton Airport	1955-66	5	5	6	5	4	2	2	2	3	7	13	9	6	8	8	6	10

TABLE 6.3

WIND SPEEDS - ANNUAL AVERAGE WIND VELOCITY (MPH)

Location	Sampling Period	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Wesleyville Site	1970-74	8.4	8.5	9.6	11.1	12.1	11.0	8.9	9.3	9.2	10.1	12.5	12.9	10.9	10.3	10.1	9.2
Toronto International Airport	1955-66	8.9	8.4	7.5	9.3	10.1	10.1	8.0	8.5	8.0	10.1	11.5	12.7	11.8	12.5	10.6	10.8
Trenton Airport	1955-66	9.2	8.1	8.9	9.6	8.9	8.9	9.2	10.9	9.5	11.2	12.0	13.3	12.7	13.7	12.0	10.9

6.1.2.3 Atmospheric Stability

Atmospheric stability defines the potential of the atmosphere to disperse airborne emissions. The diffusion and dispersion characteristics of any gaseous releases from Darlington GS A are determined by the stability of the atmosphere. Pasquill stability categories and vertical temperature gradients are the two most common methods of defining atmospheric stability conditions.

Pasquill proposed six stability categories, A (very unstable) through F (stable), which are used to aid in the prediction of dispersion patterns (16). The Pasquill categories are determined by wind speed, incoming solar radiation and cloud cover. Toronto International Airport and the Canadian Forces Base at Trenton regularly record these data, which are summarized in terms of Pasquill Stability Class System in Table 6.4 and 6.5 (15). Trenton is assumed to experience conditions which are most representative of the Darlington site.

However, the use of Pasquill categories in determining the frequency of various stability conditions is limited, since the method only records nighttime inversions. At the site, daytime inversions are expected during lake breeze occurrences when stable layers will flow off the cold lake, particularly in the spring and summer. Pasquill data must be supplemented by additional information in order to predict the frequency of inversion conditions on site during the daytime.

Vertical temperature gradients will provide this information but only limited data are available for the site at present. From data gathered during a six day on-site study (17), the vertical temperature distributions during June 1971 indicated inversions below 200 metres on each survey day. Onshore wind flows were dominant during this period. Extensive meteorological studies have been carried out at the Wesleyville site (15 miles east) and will provide data applicable to the Darlington site (140).

TABLE 6.4

PERCENT FREQUENCY DISTRIBUTION OF PASQUILL STABILITY CATEGORIES
TORONTO INTERNATIONAL AIRPORT

Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
A	3.1	3.3	3.5	4.9	5.9	7.9	9.1	9.0	7.5	5.3	3.5	3.1	6.0
B	5.7	6.1	9.2	11.1	11.0	14.5	14.5	15.5	13.6	9.9	7.0	6.6	11.0
C	12.5	12.4	15.5	16.9	17.9	18.0	17.7	16.8	16.3	13.3	11.7	11.2	16.0
D	65.5	61.2	53.4	47.3	42.2	32.1	27.9	29.4	33.7	42.9	61.1	64.3	48.0
E	6.8	7.3	8.3	8.0	8.3	8.8	9.3	8.5	9.6	9.2	6.6	6.0	9.0
F	6.4	9.7	10.2	11.8	14.7	18.7	21.4	20.8	19.3	19.3	10.1	8.7	10.0

TABLE 6.5

PERCENT FREQUENCY DISTRIBUTION OF PASQUILL STABILITY CATEGORIES
TRENTON

Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
A	3.2	3.2	3.0	3.3	3.2	4.1	4.5	5.6	5.0	3.6	3.1	3.3	4.0
B	6.5	5.9	8.5	8.7	8.4	9.7	9.7	10.9	10.9	8.1	6.4	6.2	8.0
C	11.7	12.1	15.8	17.2	16.3	17.7	16.8	16.3	16.6	14.1	11.5	10.5	15.0
D	64.6	63.5	56.6	54.4	53.4	46.6	44.6	42.5	42.8	50.4	62.9	64.2	54.0
E	5.3	5.5	6.8	6.4	6.9	7.5	9.3	8.0	8.0	8.6	5.7	5.7	7.0
F	8.6	9.9	9.3	10.0	11.6	14.5	15.1	16.6	16.7	15.2	10.4	10.1	12.0

6.1.2.4 Building Design Data

The climatology design parameters, as summarized in the Canadian Building Code, for the Bowmanville area, apply to the site (18). They are as follows:

Criteria		Data
Design Temperatures:	January 2-1/2%	-3°F
	January 1%	-6°F
	July 2-1/2% DB	86°F
	WB	75°F
Degree Days Below 65°F		7600
Rainfall	15 minute	1.1 inches
	24 hour	3.0 inches
Total Annual Precipitation		32 inches
Ground Snow Load		44 psf
Hourly Wind Pressures 10%		9.6 psf
Hourly Wind Pressures 3.3%		11.5 psf
Hourly Wind Pressures 1.0%		13.7 psf

6.2 WATER

6.2.1 Quality

6.2.1.1 Radiological

At the Pickering site, water quality has been monitored by Ontario Hydro and the Radiation Protection Services, Ontario Department of Health. In general, data suggest that the operation of the Pickering station, including heavy water upgrading plant, has had some effect on the levels of radioactivity in water. Increased tritium levels have been detected in local water supplies, but these increases are only marginally above general lake water concentrations. The resulting dose is completely negligible; the alpha and beta activities of dissolved and undissolved solids has generally been below the lower detection limits of the monitoring equipment (approximately 1 pCi/l) with the exception of the beta activity in dissolved solids which averages approximately 6 pCi/l.

Although monitoring has not been carried out at the Darlington site, it is expected that the Pickering results are representative of the activities which would be found in the lake water at this site. Ontario Hydro's planned radiological monitoring program should confirm this.

6.2.1.2 Non-Radiological

Preliminary water analysis (Table 6.6) has been carried out by Ontario Hydro at the site as part of the initial biological investigation (19). The results of the water quality surveys by the Canada Centre for Inland Waters (20) from 1966 to 1969 are summarized in Table 6.7 for several sampling points near the proposed site.

Lake surveys have also been summarized in several papers (21, 22, 23). It was found that the total salt content and the specific conductance were increasing by 4% per decade (21). Average lake-wide concentrations of trace elements (22) surveyed in 1969 are shown in Table 6.8. The highest concentrations of iron, copper, zinc and nickel occurred in the western region near the Hamilton-Toronto area. The high levels of strontium are likely caused by geochemical processes rather than human activities.

Nutrient data were collected over a period of a year in 1969 and 1970 (23). The seasonal distribution of mean bottom concentrations of ammonia, nitrate and nitrite, soluble phosphate and total phosphate remained relatively constant at 20 to 30 μg/l, 200 to 250 μg/l, 20 to 40 μg/l and 60 to 80 μg/l, respectively. The seasonal distribution of mean surface concentrations were similar except for nitrate, nitrite and soluble phosphate which decrease substantially during the summer months. This suggests the use of these compounds as nutrients for aquatic plant growth.

Secchi disc readings obtained during biological investigations offshore varied from 1 foot to 12 feet. High readings were recorded in the spring and fall, with the lowest readings found during the summer at inshore locations where the existing shoreline erosion caused turbid water (24).

Lake-wide temperature and dissolved oxygen measurements made in the summer of 1966 determined a lower limit in the main basin of 70% saturation. In the summer, the surface waters had high saturation values (100 to 155%). The mean saturation in the hypolimnion was 100% in June and 94% in September (21). Variations in the dissolved oxygen saturation values similar to the lake-wide pattern reported were found during the site biological investigation in 1972 (24). The rapid warming of the water and photosynthetic activity in early summer resulted in saturation values as high as 160% in late May (24).

The International Joint Commission report on pollution in the Great Lakes provides information on the sources and levels of pollution in Lake Ontario. There are no major municipal or industrial wastes discharged directly to Lake Ontario within five miles of the site (25).

TABLE 6.6

WATER QUALITY ANALYSIS, 1973 (19)

		Range
pH at 25°C		6.9-7.9
Turbidity	FTU	0.3-32
Secchi Disc	Ft	1.0-12 (Ref. 24)
Dissolved Solids	mg/l	184-211
Total Phosphate (PO_4)	mg/l	0.01-0.3
Nitrate (NO_3)	mg/l	0.13-1.6
Nitrite (NO_2)	mg/l	0.01-0.03
Iron (Fe)	mg/l	0.1-0.6
Manganese (Mn)	mg/l	0.1*

* single result

TABLE 6.7

WATER QUALITY ANALYSIS, 1966 - 1969 (20)

		Range
pH at 25°C		8.0-8.8
Specific Conductivity	micromhos	285-352
Turbidity	FTU	0.1-4.0
Dissolved Oxygen	mg/l	7.6-14.4
Total Phosphate	mg/l	0.005-0.130
Kjeldahl Nitrogen (N)	mg/l	0.3-1.6
Ammonia (N)	mg/l	0.005-0.220
Nitrate and Nitrite (N)	mg/l	0.002-0.590
Total Alkalinity ($CaCO_3$)	mg/l	60-97.5
Hardness ($CaCO_3$)	mg/l	126-138
Phenol	mg/l	0.000-0.010
Chloride	mg/l	22.5-29
BOD (C)	mg/l	0.3-1.6

TABLE 6.8

AVERAGE VALUES OF TRACE ELEMENTS, 1969 (22)
LAKE ONTARIO

Element	ug/l
Cadmium (Cd)	0.09
Chromium (Cr)	0.74
Cobalt (Co)	0.11
Copper (Cu)	6.40
Iron (Fe)	5.12
Lead (Pb)	0.83
Manganese (Mn)	0.47
Molybdenum (Mo)	1.08
Nickel (Ni)	2.32
Strontium (Sr)	184.70
Vanadium (V)	0.03
Zinc (Zn)	7.84

An investigation of the "thermal bar" phenomenon has been carried out offshore from the Darlington site (26). The thermal bar acts as a barrier separating the warmer, more productive inshore waters from the mid-lake waters and also inhibits the diffusion of chemicals and bacteria from the inshore to the offshore area. The thermal bar in Lake Ontario lasts for a period varying from four to eight weeks.

6.2.2 Currents

6.2.2.1 Ambient Lake Conditions

Lake currents were recorded by Ontario Hydro from June to November 1971, and April to November 1972 using an in-situ current and temperature recorder which was located on the site centreline 4,000 feet offshore at about 25-foot depth in about 46 feet of water. Frequency of occurrence by direction and speed class is given for 1971 in Tables 6.9 and 6.10 and for 1972 in Tables 6.11 and 6.12. In addition, these frequencies of occurrence for the two years are compared in Figures 6-2 and 6-3.

The current patterns were essentially the same in 1971 and 1972. Lake currents were to the east and west quadrants, or alongshore, almost 80% of the time with a predominance to the west quadrant. The direction of the net transport was toward the west and south-west. Current direction and speed by quadrants for the two years are summarized below:

CURRENT DIRECTION (TO)	1971 Jun 3-Nov 8	1972 Apr 14-Nov 30
E (% Time)	31	30
W (% Time)	48	48
N (% Time)	5	6
S (% Time)	16	14
Calm (% Time)	-	2
Total E&W Quad. (% Time)	79	78
Net	233°	252°
CURRENT SPEED (ft/sec)		
Mean	0.32	0.33
Max.	1.00	0.96
Net Magnitude	0.09	0.07

TABLE 6.9

LAKE CURRENTS
FREQUENCY OF OCCURRENCE AND TRANSPORT BY DIRECTION

1971
JUNE 3 - NOVEMBER 8

CURRENT DIRECTION (TO)	OCCURRENCE		TRANSPORT		SPEED IN FT/SEC	
	HOURS	PERCENT	FT. x 10^3	PERCENT	AVERAGE	MAXIMUM
N	26	0.69	10.98	0.25	0.12	0.30
NNE	37	0.98	20.70	0.47	0.16	0.40
NE	88	2.33	65.34	1.49	0.21	0.35
ENE	145	3.84	122.22	2.79	0.23	0.60
E	489	12.95	540.18	12.32	0.31	1.00
ESE	391	10.35	534.60	12.19	0.38	0.95
SE	165	4.37	212.94	4.86	0.36	0.70
SSE	165	4.37	183.78	4.19	0.31	0.70
S	165	4.37	178.74	4.08	0.30	0.75
SSW	124	3.28	122.58	2.80	0.27	0.70
SW	184	4.87	199.62	4.55	0.30	0.75
WSW	478	12.66	600.48	13.70	0.35	0.95
W	985	26.08	1331.82	30.38	0.38	0.90
WNW	208	5.51	183.60	4.19	0.25	0.60
NW	93	2.46	59.58	1.36	0.18	0.40
NNW	32	0.85	16.74	0.38	0.15	0.25
CALM	2	0.05				
TOTAL	3777	100.00	4384.44	100.00		

Net current speed is 0.09 ft/sec at 233 degrees. Mean current speed is 0.32 ft/sec.

Persistence factor $\frac{(V_{net})}{(V_{mean})}$ is 0.29.

TABLE 6.10

LAKE CURRENTS
PERCENTAGE FREQUENCY BY DIRECTION AND SPEED CLASS

1971
JUNE 3 - NOVEMBER 8

CURRENT DIRECTION (TO)	CURRENT SPEED IN FT./SEC.							
	0.00 - .19	.20 - .39	.40 - .59	.60 - .79	.80 - .99	1.00 - 1.19	≥1.20	TOTAL
N	0.58	0.11	0.00	0.00	0.00	0.00	0.00	0.69
NNE	0.66	0.29	0.03	0.00	0.00	0.00	0.00	0.98
NE	0.82	1.51	0.00	0.00	0.00	0.00	0.00	2.33
E	1.09	2.57	0.16	0.03	0.00	0.00	0.00	3.84
E	1.64	8.47	2.09	0.56	0.16	0.03	0.00	12.95
ESE	1.01	4.85	2.62	1.62	0.26	0.00	0.00	10.35
SE	0.98	1.32	1.35	0.71	0.00	0.00	0.00	4.37
SSE	1.03	1.91	1.16	0.26	0.00	0.00	0.00	4.37
S	1.09	1.96	1.03	0.29	0.00	0.00	0.00	4.37
SSW	1.03	1.48	0.58	0.19	0.00	0.00	0.00	3.28
SW	1.03	2.44	1.19	0.21	0.00	0.00	0.00	4.87
WSW	1.54	6.38	3.07	1.40	0.26	0.00	0.00	12.66
W	2.83	11.38	8.50	3.02	0.34	0.00	0.00	26.08
WNW	1.32	3.47	0.66	0.05	0.00	0.00	0.00	5.51
NW	1.27	1.11	0.08	0.00	0.00	0.00	0.00	2.46
NNW	0.50	0.34	0.00	0.00	0.00	0.00	0.00	0.85
CALM	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05
TOTAL	18.48	49.59	22.53	8.34	1.03	0.03	0.00	100.00

TABLE 6.11

LAKE CURRENTS
FREQUENCY OF OCCURRENCE AND TRANSPORT BY DIRECTION

1972
APRIL 14 - NOVEMBER 30

CURRENT DIRECTION (TO)	OCCURRENCE		TRANSPORT		SPEED IN FT/SEC	
	HOURS	PERCENT	FT. x 10^3	PERCENT	AVERAGE	MAXIMUM
N	19	0.35	13.54	0.21	0.20	0.70
NNE	66	1.23	68.47	1.08	0.29	0.58
NE	183	3.41	197.32	3.11	0.30	0.68
ENE	309	5.76	278.50	4.39	0.25	0.80
E	899	16.75	1237.79	19.49	0.38	0.92
ESE	237	4.42	250.85	3.95	0.29	0.72
SE	166	3.09	149.54	2.35	0.25	0.70
SSE	196	3.65	209.45	3.30	0.30	0.70
S	292	5.44	301.68	4.75	0.29	0.68
SSW	107	1.99	96.05	1.51	0.25	0.54
SW	178	3.32	167.83	2.64	0.26	0.68
WSW	434	8.09	471.74	7.43	0.30	0.80
W	1568	29.22	2210.54	34.81	0.39	0.96
WNW	444	8.27	540.43	8.51	0.34	0.95
NW	132	2.46	118.12	1.86	0.25	0.74
NNW	51	.95	38.70	0.61	0.21	0.50
CALM	86	1.60	0.00	0.00	0.00	-
TOTAL	5367	100.00	6350.65	100.00		

Net Transport: speed - 0.07 ft/sec., direction 252 degrees.
Mean current speed - 0.33 ft./sec.
Maximum current speed - 0.96 ft./sec.

Persistence factor ($\frac{V_{net}}{V_{mean}}$) = 0.22

TABLE 6.12

LAKE CURRENTS
PERCENTAGE FREQUENCY BY DIRECTION AND SPEED CLASS

1972
APRIL 14 - NOVEMBER 30

CURRENT DIRECTION (TO)	CURRENT SPEED IN FT./SEC. 0.00 -0.19	0.20 -0.39	0.40 -0.59	0.60 -0.79	0.80 -0.99	1.00	TOTAL
N	0.19	0.15	0.00	0.02	0.00	0.00	0.35
NNE	0.45	0.47	0.32	0.00	0.00	0.00	1.23
NE	0.78	1.63	0.89	0.11	0.00	0.00	3.41
ENE	2.13	3.15	0.28	0.19	0.02	0.00	5.76
E	3.75	6.04	2.79	3.28	0.89	0.00	16.75
ESE	1.64	1.34	1.16	0.28	0.00	0.00	4.42
SE	1.45	0.76	0.71	0.17	0.00	0.00	3.09
SSE	1.04	1.64	0.82	0.15	0.00	0.00	3.65
S	1.53	2.59	1.19	0.13	0.00	0.00	5.44
SSW	0.75	0.88	0.37	0.00	0.00	0.00	1.99
SW	1.21	1.29	0.75	0.07	0.00	0.00	3.32
WSW	1.94	4.29	1.49	0.34	0.04	0.00	8.09
W	3.35	12.71	8.27	4.40	0.48	0.00	29.22
WNW	1.49	3.82	2.27	0.45	0.24	0.00	8.27
NW	1.10	0.91	0.41	0.04	0.00	0.00	2.46
NNW	0.47	0.35	0.13	0.00	0.00	0.00	0.95
CALM	1.60	0.00	0.00	0.00	0.00	0.00	1.60
TOTAL	24.86	42.00	21.86	9.61	1.68	0.00	100.00

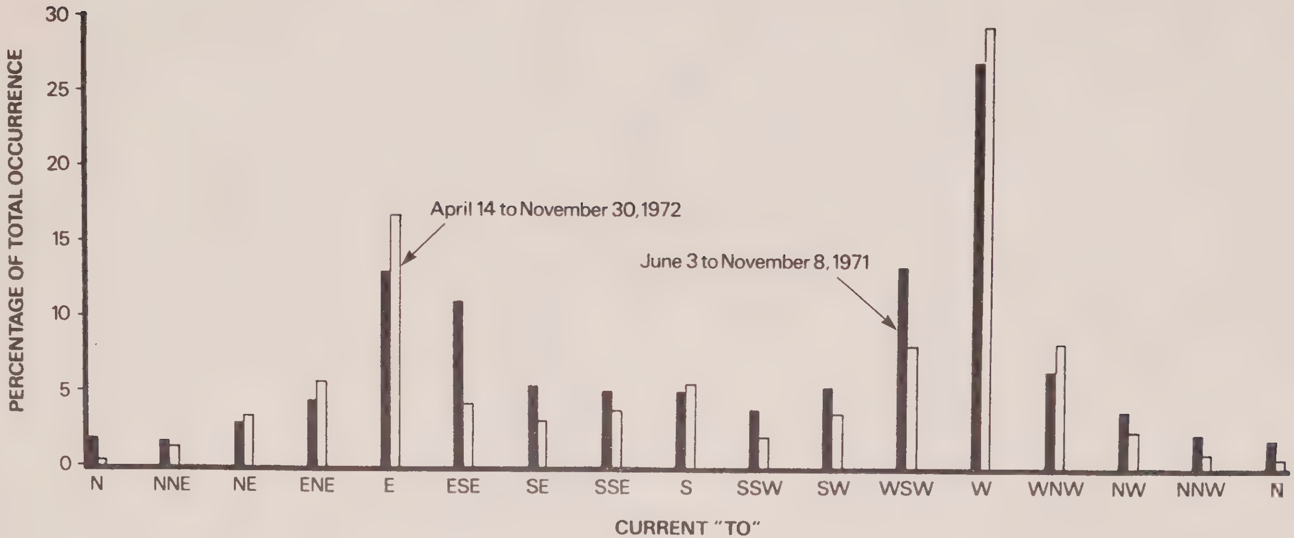


FIGURE 6–2 FREQUENCY OF LAKE CURRENTS AT DARLINGTON SITE 1971–1972

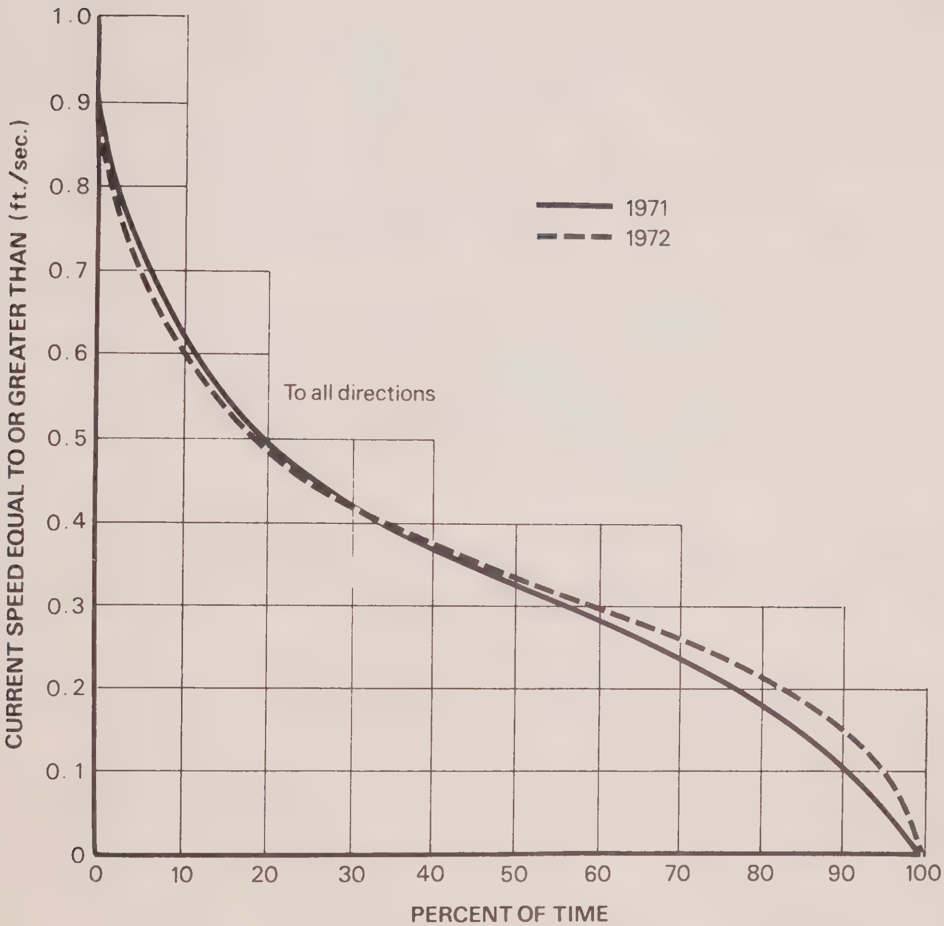


FIGURE 6–3 DARLINGTON SITE DURATION CURVES OF CURRENT SPEED 1971 AND 1972

6.2.3 Temperatures

6.2.3.1 Ambient Lake Conditions

Water temperatures were recorded by Ontario Hydro offshore from the Darlington site at depths of 5, 26, and 70 feet from May to November of 1971, and at depths of 5, 25, 40, and 70 feet from May to November of 1972. These temperatures are summarized by months in Tables 6.13 and 6.14 in terms of monthly mean, maximum and minimum daily mean, and hourly maximum and minimum. The temperatures differed appreciably from one year to the next. At 5-foot depth about 100 feet offshore the temperature records were incomplete, however, the warmest temperatures that were recorded occurred in August of both years, the maximum daily being 71°F and the maximum hourly, 77°F. At 25-foot or 26-foot depth, 4,000 feet offshore, the highest monthly mean temperatures were 63°F in September 1971, and 58°F in August and September 1972, the maximum daily for the two years was 69°F and the maximum hourly, 71°F. At 70-foot depth, 7,000 feet offshore, the highest monthly mean temperatures were 57°F in September 1971, and 51°F in August and September 1972, the maximum daily for the two years was 68°F, and the maximum hourly, 70°F.

Large temperature variations occurred from day-to-day, and within the day on several occasions during both 1971 and 1972. Consecutive daily mean temperatures varied by as much as 18F° at 5-foot depth, 14F° at 26-foot depth and 13F° at 70-foot depth. Hourly temperatures varied within the day by as much as 22F° at 5-foot depth, 23F° at 26-foot depth and 16F° at 70-foot depth. Figure 6-4 shows the continuous record of daily mean temperatures observed in 1972.

Vertical temperature profiles obtained in 1971 and 1972 at various distances offshore up to 9,000 feet indicated surface warming commencing in June, large temperature gradients in July and August and a return to isothermal conditions in October.

Offshore water temperatures have been measured during water quality surveys by the Canada Centre for Inland Waters (CCIW) (20) from 1966 to 1969, and during aquatic biological investigations carried out by Ontario Hydro during 1972 (24). In 1969, the CCIW found that the vertical temperature profile increased from an isothermal 4°C in April following the pattern described above to a September maximum of 21°C returning to an isothermal 3°C in December (20). The vertical temperature data for a bottom fauna sampling station 2000 feet from shore are shown in Table 6.15 for the period May to October, 1972 (24).

TABLE 6.13

LAKE ONTARIO WATER TEMPERATURE °F, 1971

	Distance from Shore (feet)	Depth (feet)	May	Jun	Jul	Aug	Sept	Oct	Nov
Monthly	100	5		57	53	58		53*	
Mean	4,000	26		51*	47	55	63	54	
	7,000	70		41	41	47	57	50	
Max.	100	5	49*	67	66	70	68*	57	
Daily	4,000	26		64	62	66	69	62	57*
Mean	7,000	70	41*	44	46	59	68	59	54*
Min.	100	5		46	44	47	64	47	
Daily	4,000	26		43	40	40	52	42	
Mean	7,000	70		40	39	40	51	40	
Max.	100	5	50*	72	69	73	77*	59	
Hourly	4,000	26		66	65	68	70	63	58*
Min.	100	5		44	42	45	63*	46	
Hourly	4,000	26		40	38	39	44	41	

* Partial month

TABLE 6.14

LAKE ONTARIO WATER TEMPERATURE °F, 1972

	Distance from Shore (feet)	Depth (feet)	May	Jun	Jul	Aug	Sept	Oct	Nov
Monthly Mean	100	5		47*		64*	60	48	
	4,000	25	43*	46*	47	58	58	47*	46
	4,000	40	43	43	46*	55	54	48	46
	7,000	70			44	51	51	46	
Max. Daily Mean	100	5		55*		71*	68	61	
	4,000	25	46*	53*	54	67	62	60*	50
	4,000	40	47	54	52*	64	61	61	49
	7,000	70			46	59	60	59	48*
Min. Daily Mean	100	5		41*		53*	53	40	
	4,000	25	40*	41*	43	45	47	40*	41
	4,000	40	40	39	42*	43	44	41	42
	7,000	70			42	42	43	40	
Max. Hourly	100	5		63*		74*	72	61	
	4,000	25	49*	54*	59	71	65	61*	50
	4,000	40	48	54	53*	66	62	63	50
	7,000	70			47	64	61	59	48*
Min. Hourly	100	5		37*		47*	47	40	
	4,000	25	39*	39*	41	42	42	40*	40
	4,000	40	39	38	42*	43	43	41	41
	7,000	70			41	41	43	40	

* Partial month

TABLE 6.15

VERTICAL TEMPERATURE DATA
BIOLOGICAL INVESTIGATIONS 1972

Temp ^{o}C

Depth feet	May 25	Jun 29	Jul 21	Aug 18	Sept 20	Nov 2
0	11.5	12.0	18.5	16.7	11.2	8.1
5	10.2	10.2	17.0	16.6	10.7	8.1
10	9.5	9.8	12.5	16.5	10.7	8.1
15	8.3	9.3	10.5	16.4	10.4	8.1
20	8.0	8.8	10.0	16.4	10.3	8.1
25	7.8	8.8	10.0	16.4		

Data recorded at bottom fauna sampling station 2000 feet from shore (24)

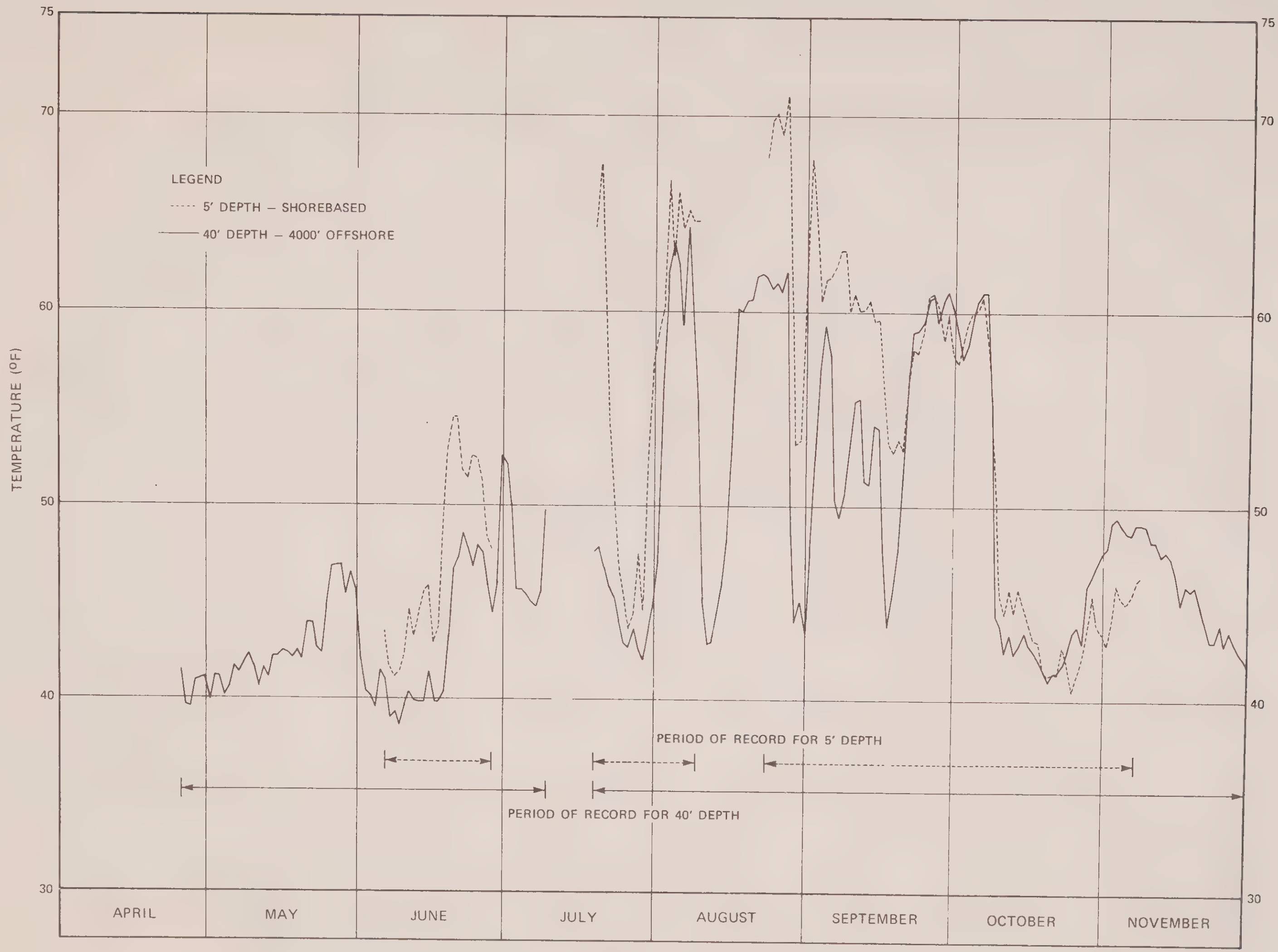


FIGURE 6–4 DAILY MEAN WATER TEMPERATURE AT THE DARLINGTON SITE – 1972

6.2.4 Ice

Limited observations of ice conditions in Lake Ontario in the vicinity of the site have been made beginning in 1971. The observations consisted of general reconnaissance from an aircraft and of ground observations to determine ice conditions along the shore. No extensive ice cover has been observed, only shore and slush ice which has developed into ridges extending as much as 100 feet from shore.

6.2.5 Aquatic Life

6.2.5.1 Fish

Improving water quality and the recent trends to reintroduce fish species has strongly influenced the character of Lake Ontario fisheries. Two recent Ministry of Natural Resources surveys (27, 28) identify local fishing and spawning sites. Several creeks within seven miles of the Bowmanville site are open to migrating rainbow trout. These include Oshawa and Harmony Creeks (five miles west), Darlington and Soper Creeks (three miles east), Wilmot Creek (six miles east) and Graham Creek (seven miles east). Coho salmon have been caught in two areas; at the mouth of Wilmot Creek and off Bond Head. The area off Bond Head is also a long established spawning area for smelt and was once heavily populated by whitefish and white bass. Rainbow trout are also suspected to spawn here. The area off Port Granby (thirteen miles east of the Darlington site) is a spawning area for jumbo smelt, whitefish and rainbow trout. There is a secondary stream at Port Granby which has potential for migrating rainbow trout and is used by commercial bait fish operators. A broadly defined area, approximately fourteen miles southeast of the Darlington site (twelve miles offshore from the Port Granby to Lakeport region), is frequented by commercial fishermen. The area is noted for jumbo smelt, lake trout and was formerly known as a major lake trout spawning area. Figure 6-5 illustrates the location of these areas.

In 1971 there were three individuals licensed to take bait fish from waters entering Lake Ontario within 10 miles of the Darlington site. These operators recorded a catch for the year of approximately 600 dozen shiner, chub, sucker, dace and darter minnows for sale to the angling public. There were 21 individual licensees along the entire Lindsay District shoreline who held 24 licences for 117,000 yards of gillnet, 15 trap nets and 450 baited hooks (28).

The commercial fish harvest based on landings and values by species during 1971, 1972 and 1973 is summarized in the following table (42):

Species	1971		1972		1973	
	lbs.	$	lbs.	$	lbs.	$
Carp	29	3	-	-	93	23
Eels	190	0	-	-	100	15
Northern Pike	33	10	42	13	-	-
Yellow Perch	57	10	-	-	-	-
Sucker (Mullet)	31	0	-	-	-	-
Smelt	32,952	7,380	30,266	6,898	12,990	4,224
White Bass	15	3	-	-	-	-
Lake Whitefish	-	-	46	27	21	0
Animal Food * (Unclassified)	-	-	13	0	28	0
Total Landings (lbs)	33,307		30,367		13,232	
Total Landed Value ($)		$7,406		$6,938		$4,262

* Animal Food includes mixed scrap fish

In 1972 an Ontario Hydro study (24) indicated that the fish populations off the site were low. Trap nets, set during the period of May to October at three locations (Figure 6-6), found fourteen fish species. The species and corresponding number of each caught during the study is given as follows:

Alewife	-	_Alosa pseudoharengus_...........489
Sucker	-	_Catostomus commersonni_.........255
Brown Bullhead	-	_Ictalurus nebulosus_............59
White Perch	-	_Morone americana_...............11
Yellow Perch	-	_Perca flavescens_...............10
American Eel	-	_Anguilla rostrata_...............9
Smelt	-	_Osmerus mordax_..................6
Carp	-	_Cyprinus carpio_.................4
Sunfish	-	_Lepomis macrochirus_.............3
Chub	-	_Couesius plumbeus_...............3
Pumpkinseed	-	_Lepomis gibbosus_................2
Lamprey	-	_Petromyzon marinus_..............1
Silver bass	-	_Morone chrysops_.................1
Rock Bass	-	_Ambloplites rupestris_...........1

Over half of the alewives were caught in May.

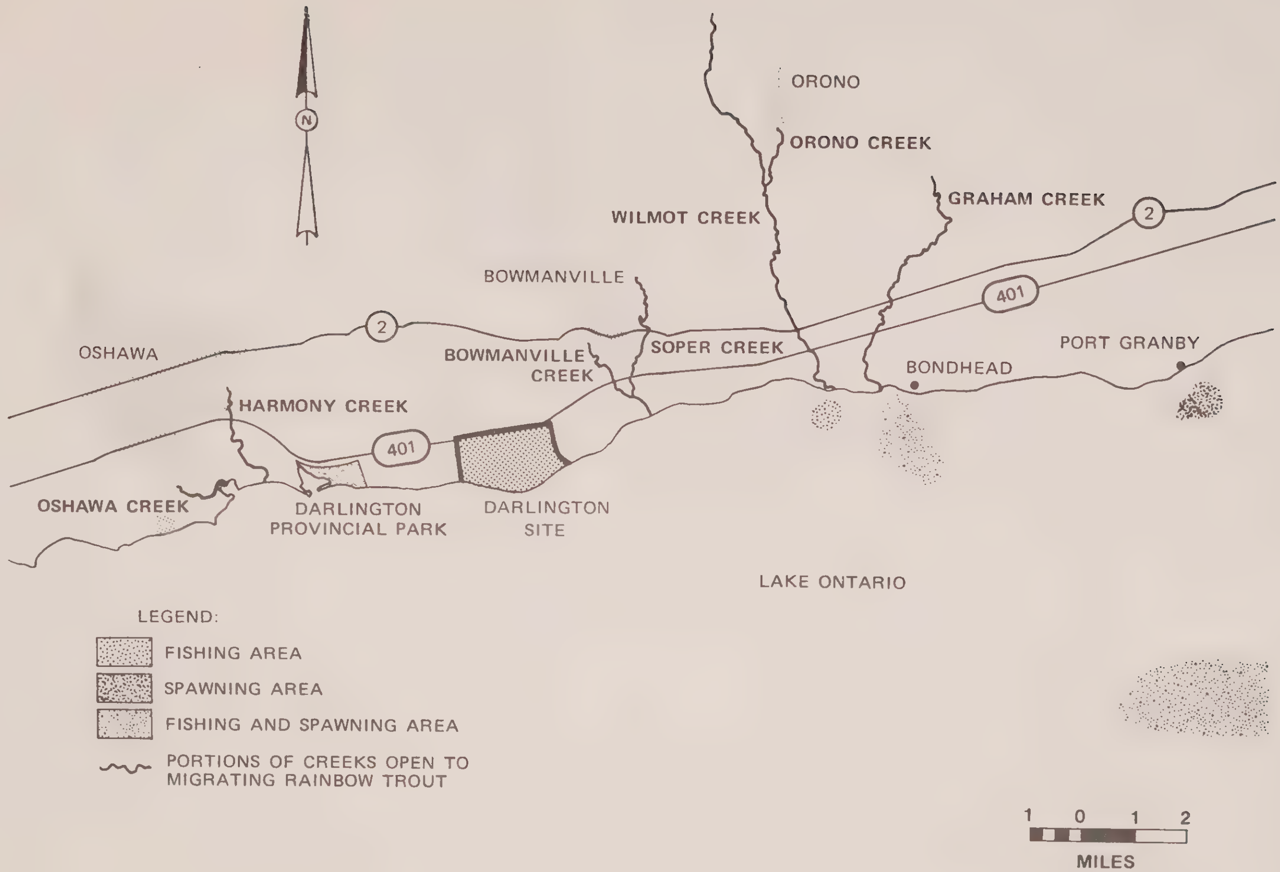


FIGURE 6–5 FISHING AND SPAWNING AREAS

FIGURE 6–6 AQUATIC BIOLOGY STUDY SITES DARLINGTON – 1972

6.2.5.2 Bottom Fauna

An area extending from the western end of the Scarborough Bluffs to east of the Darlington site was surveyed for bottom fauna in 1966-1967 (25). The results are indicative of oligotrophic conditions. The average community based on numbers per unit area consisted of:

amphipods	39.0%
lumbiculids	24.0%
midges	12.0%
clams	12.0%
tubificids	12.8%

An Ontario Hydro study in 1972 (24) made monthly measurements of bottom fauna at six locations in two depths (Figure 6-6). Apart from large numbers of Hydra (Coelenterata), found in September and October, the populations were dominated by Asellus (Isopoda) and Gammarus (Amphipoda). Populations were similar to other sites along the northern shoreline of Lake Ontario such as Lakeview (51), Pickering (105, 106) and Wesleyville generating stations.

6.2.5.3 Phytoplankton

The central part of the lake is characterized by low densities of algae and fairly homogeneous lateral distribution of plankton, whereas the inshore areas show a more irregular but higher distribution pattern. Diatoms, cryptomonads and green algae, in that order, are the most important constituents of the lake phytoplankton, while chrysomonades and dinoflagellates do not play the role they could have been expected to, from the temperature and nutrient conditions of the lake. The annual average composition of the phytoplankton for the general area around the Darlington site was found to be (29):

Cyanophyta	10%	(blue-green)
Chlorophyta	16%	(green)
Chrysomonadinae	15%	(yellow-green)
Diatomeae	33%	(diatoms)
Cryptomonadinae	20%	(yellow-brown flagellates)
Dinophycinae	6%	(armoured flagellates)

In the winter and spring, diatoms are 80% of the plankton volume. The plankton in the summer maximum and the fall show more diversity, with green algae as the biggest single group, followed in importance by blue-greens and cryptomonads. A pronounced spring maximum appears in the inshore region. The summer maximum develops earlier but more irregularly in the offshore region. Stations are defined as inshore if they are less than 25 metres deep (29).

The persistence of certain diatom species within the inshore regions during all seasons of the year may be indicative of eutrophic conditions in the near shore waters of Lake Ontario (25). In the main

body of the lake, however, phytoplankton concentrations indicate mesotrophic to oligotrophic conditions.

Ontario Hydro studies in 1972 (24) showed that *Asterionella*, *Fragilaria*, *Nitzschia* and *Tabellaria* were common diatoms, *Ulothrix* the only common green alga and *Oscillatoria* a common blue-green alga in July. Percentage composition by month was found to be:

Month	Diatoms	Greens	Blue-green
Apr	43	57	0
May	41	50	9
Jul	48	7	45
Aug	75	23	2
Sept	76	24	0

6.2.5.4 Zooplankton

There is very little published information on the zooplankton population in the vicinity of the Darlington site. The Ministry of the Environment sampled in Lake Ontario regularly between May and September 1967. On the average, the eastern part of the lake was richer in planktonic crustacea than the western and central parts (25).

An Ontario Hydro study in 1972 (24) indicated only low numbers at the surface and 10 foot depths except in August. *Bosmina* was the most common species, followed by *Cyclops*, *Daphnia*, *Kellicottia*, *Keratella* and *Polyarthra*.

6.2.5.5 Periphyton and Aquatic Macrophytes

Fairly dense growths of the filamentous alga, Cladophora, in the shallow water near the site have been observed (30). The rocky, shallow nature of the shoreline, a moderate nutrient content and good water turbulence contribute to the dense growth, whereas the high turbidity of the water in the vicinity of the site will tend to restrict the growth. The algae first appears in late May with rapid growth and spreading occurring during May, June and July. Heavy wave action causes fragmentation after this time and with onshore wind conditions, shoreline accumulations can result. The process of fragmentation and shoreline accumulation carries on into September and October.

6.2.5.6 Bacteriology

The bacteriological quality of the water in the vicinity of the Darlington site is good (25). The bacteriological quality of Lake Ontario is excellent in deep water but is somewhat degraded along the shoreline and in harbour areas. The coliform-polluted areas appear to

be limited to water well within two miles off the shoreline from the source. High bacterial densities show a close correlation with heavily polluted areas. The area in the vicinity of the site is not highly populated or industrialized. Oshawa and Bowmanville are the two nearest communities whose sewage treatment effluents are discharged into Harmony Creek (five miles west) and Soper Creek (three miles east). The spring thermal bar phenomenon (26) may increase the bacterial density in the nearshore area by prohibiting proper dispersion in the lake.

6.2.6 Surface and Ground Water

The surficial soil within the site area is fairly well drained and no large permanent drainage system has developed. However, there are several small, steep-walled gullies and a few small poorly drained swampy areas within the site. In the west half of the site where the proposed Darlington GS A is located, these gullies and poorly drained areas are found close to the shorecliff near the western site boundary.

The ground water level as indicated in the observation wells is about 5 to 20 feet below the ground surface. The trend of the ground water movement is from north to south, and approximately perpendicular to the shoreline with a relatively flat gradient. However, readings from piezometers located within the interglacial sands and silts immediately below the upper till layer show that a piezometric water level, generally 5 to 15 feet higher than the ground water level in the area, exists. Along the proposed cut slopes between the switchyard and the powerhouse yard areas, the piezometric water level is 10 to 15 feet higher, causing artesian or sub-artesian conditions in some places.

6.3 SITE AREA

6.3.1 Topography

The Darlington site is situated in an undulating to moderately rolling limestone till plain spotted with remnants of a lake plain deposit. Along the shore, steep to near vertical cliffs rise some 40 to over 100 feet above the mean lake water level of El. 245. This shorecliff is continually being eroded by wave action from the lake. Presently, the shoreline is receding at a rate of about three feet per annum. Inland, the terrain is irregular but generally rises towards the north. The mean ground surface elevation south of the CNR tracks is at about El. 300. North of the tracks, the ground is about 50 feet higher. A high ridge, starting from the shore just east of Raby Head, extends diagonally across the site in a northwesterly direction with levels ranging up to 50 feet above the surrounding ground.

On the west half of the site where Darlington GS A is to be located, the land is generally higher than the east half, ranging from El. 280 to El. 320 along the top of the shorecliff to El. 340 at the CNR tracks, and to a high of El. 420 near the north boundary of the site.

6.3.2 Geology

The land portion of the site area is covered by a thin layer of top soil and glacio-lacustrine silts and clays generally less than 10 feet thick. Underneath is a layer of dense to very dense, well-graded, sandy silty till of varying thickness, from 0 to about 80 feet, but generally between 20 and 50 feet. Below the till is a thick deposit (up to 70 feet) of complex interglacial materials consisting of dense, layered, uniform sands and silts and slightly plastic silts and clays. Underneath the interglacial materials and immediately over bedrock is a relatively thin, generally less than 10 feet, layer of very dense, silty till.

Bedrock is not exposed anywhere within the site. From information obtained during site investigations and from a quarry located at about 1,000 feet east of the site, it is found that bedrock belongs to the Black River-Trenton Limestone Group of Middle Ordovician period. The bedrock consists of dark brown, fresh, dense, thin-bedded, and flat-lying shaly limestone up to about 30 feet thick, conformably overlying a gray, fresh, dense, medium to massive bedded, fossiliferous limestone in excess of 135 feet thick. Generally the bedrock surface is flat from east to west, but slopes down gently towards the lake from El. 225 near the CNR track to El. 202 at the shoreline near Raby Head.

Offshore, both the glacio-lacustrine and the upper sandy till layers are absent. The lake bottom is covered with the interglacial sands and silts or with a thin layer of beach sand, gravel and cobbles possibly derived from the erosion of material in the shorecliffs.

The limestone bedrock is similar to that found on-shore and may be encountered from 5 to about 40 feet below the lake bottom with thicker overburden found near the shore. The bedrock surface continues to slope down gently into the lake at about 20 feet per mile.

6.3.3 Seismology

Based on the seismic zoning map published by the Federal Department of Energy, Mines and Resources in 1969, and incorporated into the National Building Code of Canada, the Darlington site is located within seismic zone 1 with minor earthquake damage probability. The probable return period for a seismic shock with a ground acceleration equivalent to 3% gravity or less, is estimated at 100 years for Zone 1. The Darlington site could have lower acceleration than 3% gravity for 100 year return period.

6.3.4 Vegetation

The site area has been previously cleared of its tree cover for agricultural purposes. Several wooded and scrub areas exist on the site along with those trees which line roadways and property boundaries.

The commercial forest capability of the area ranges from land with no limitations to land with only slight limitations due perhaps to excessive soil moisture. In areas of drier soil, trees common to the area include white pine, red oak, white oak, sugar maple, beech, basswood, white ash and black cherry. On wet sites, white cedar and black ash are found with tamarack being found on very wet sites (28).

Typical vegetation found about the marsh areas include common cat-tail, sedges, grasses and rushes with duckweed and pond lilies found in the pools of the marshes (28).

6.3.5 Wildlife

The wildlife resource of this section of the Lake Ontario shoreline tends to be centred about the marsh areas near the site which open onto the lake. The waterfowl capability of these marshes is very good. The most numerous of the migratory waterfowl species include mallards, black ducks, scaup and Canadian geese. Darlington Marsh and Oshawa Second Marsh, noted for their waterfowl, lie partly within Darlington Provincial Park, to the west of the site. A controlled put-and-take pheasant hunt takes place yearly at Darlington Provincial Park. Oshawa First Marsh, further west, is also noted for its waterfowl. Two marshes to the east of the Darlington site (Bowmanville and West Side Marshes) are noted as well for muskrat trapping and have a high potential for wildlife viewing (28).

The immediate site area has only slight limitations with respect to its capability to support deer (white tailed) production. Other smaller mammals which inhabit the area include European hare, squirrels, various types of mice, groundhogs and striped skunk.

6.3.6 Recreational and Historical Significance

The Historical Sites Branch of the Ministry of Natural Resources has conducted a basic level inventory to determine whether the site has any historical significance. This investigation, completed during the summer of 1974, found that the site is of no historical importance. It was never occupied by aboriginal peoples due to several prohibitive factors such as the high shoreline bluff which prevents access to and from Lake Ontario, the lack of surface water and the heavy nature of the soil which made early agricultural pursuits very difficult.

With regard to recreation, the lakefront within the boundaries of the Darlington site property is not ideally suited for swimming or other water-oriented recreational activities. In fact, the shoreline has developed into a steep bluff due to rapid wave action erosion.

6.4 COMMUNITY AND LAND USE

6.4.1 Regional and Local Municipal Development

6.4.1.1 Residential Development

The site of the proposed station is located in the new Town of Newcastle, which was established upon formation of the new Regional Municipality of Durham on January 1, 1974. Bill 162 replaced 21 local municipalities with eight new area municipalities (Figure 6-7) and reallocated all municipal responsibilities between them and the Regional Municipality.

Rapidly escalating house prices, resulting from a shortage of dwelling units in Metro Toronto, have forced many people to relocate to the east and west, and commute to their place of employment. The new Town of Newcastle has experienced a significant amount of this new housing demand with resulting extensive residential construction activity.

A brief description of communities is as follows:

(i) New Town of Newcastle

This municipality was established on January 1, 1974, as one of eight new area municipalities within the new Regional Municipality of Durham. It was formed by the amalgamation of the Townships of Darlington and Clarke, the Town of Bowmanville, and the Village of Newcastle. The total 1971 population of the amalgamated municipalities was over 27,000.

Various large housing projects have been proposed for this Area Municipality including an 800-home subdivision in the southeast corner of Port Granby, a 1000-home subdivision just west of the community of Newcastle, and 40-50 homes near Eniskillen. All are subject to approval by both the Area and Regional Municipalities.

(ii) Community of Bowmanville

This community, formerly incorporated as a Town, is the only large urban centre within five miles of the proposed station. Its population (8950 in 1971) is presently growing rapidly due to the construction of several large housing subdivisions. Housing projects, either under construction or already approved, are likely to cause existing sewage and water treatment facilities to reach their capacity much sooner than originally planned by the community (see Section 6.4.1.2).

FIGURE 6–7 REGIONAL MUNICIPALITY OF DURHAM

(iii) City of Oshawa

The City of Oshawa, approximately six miles to the west, has become a major regional industrial/residential centre. Its 1971 population of 91,590 is expected to grow to 145,000 by the year 1986 and 200,000 by the year 2001.

According to the proposed Official Plan of the Oshawa Planning Area, the Oshawa and Whitby water supply systems are to be integrated within the next five years. This would ensure enough capacity to serve Oshawa's projected population for the next six to eight years. With regard to sewage treatment, the 1973 Industrial Survey of Ontario Municipalities, issued by the Ministry of Industry and Tourism, reports that this facility is already operating at close to capacity.

(iv) Community of Newcastle

This community, formerly incorporated as a Village, is located approximately seven miles east of the site. The population of this community was 1,940 in 1971. Almost 150 lots have recently been approved for construction of residential units but are awaiting extension of services. Many additional plans have been proposed for housing construction in this community, but have been hindered by unavailability of required sewage treatment and water supply facilities.

Water supply and sewage treatment facilities for the communities of Bowmanville and Newcastle, and for the City of Oshawa, are described in Table 6.16.

TABLE 6.16

Municipal Services
Water Treatment Facilities

Urban Centre	Source	Treatment	Total Capacity of Works (MGD)	1972 Avg. (MGD)	Remarks*
Bowmanville	1) Lake Ontario 2) Skinners Springs & Malkie Creek	Complete Chlorination	2.3	0.696	
Newcastle	One Municipal Well	Chlorination	0.144	0.05	1
Oshawa	Lake Ontario	Complete & Fluoridation	33.0	12.5	2

* Remarks

1. An additional well, which is designed to double the current capacity of water supply, is scheduled for operation in 1974.
2. Plans are being prepared for expansion due to anticipated population growth in coming years.

TABLE 6.16 (cont'd)

Municipal Services
Sewage Treatment Facilities

Urban Centre	Treatment	Effluent Discharge Point	Total Capacity of Works (MGD)	1972 Avg. (MGD)	Remarks**
Bowmanville	1) Trickling Filter 2) Activated Sludge	Soper Brook	1.5	1.06	
Newcastle	ISTS*				1
Oshawa	1) Trickling Filter	Harmony Creek	7.5	7	2,3
	2) Primary		5	2.9	

*ISTS - Individual septic tank systems

**Remarks

1. A new prefabricated combined extended aeration - contact stabilization type plant is under construction. Design capacity will be 0.28 MGD initially, 0.4 MGD ultimately.
2. Plans are to upgrade the Trickling Filter plant to a secondary treatment facility with a capacity of 12.5 MGD in 1975.
3. Oshawa also sends an average 0.5 MGD of sewage to a 2.0 MGD capacity secondary treatment plant in Whitby. Capacity of this plant will be doubled to 4.0 MGD in 1974.

6.4.1.2 Planned Development

The Darlington site is located in the recently-formed Central Ontario Planning Region whose boundaries are shown in Figure 6-8. This new Region is an enlargement of the former Toronto Centred Region (TCR) of which policies established to provide direction over future growth are still valid. The site is just within the eastern boundary of the primary development zone of the former TCR, the Lake Ontario Urbanized Area. The nearest urban centre to the site is the community of Bowmanville and the nearest regional centre is the City of Oshawa.

The Central Ontario Region also encompasses most of the former Lake Ontario Economic Region. A report prepared by the Ministry of Treasury, Economics and Intergovernmental Affairs (TEIGA) in June, 1972, entitled "Design for Development, Prospects for the Lake Ontario Region", briefly summarizes development trends in the area, and discusses three alternative techniques of shaping future growth. The report states that a trend has developed in the southern portion toward settlement by those who prefer to live in smaller communities and commute to larger centres. Bowmanville is a centre of much of this new growth. Furthermore, alternative patterns of growth suggested by the report all include Bowmanville and the project site area within a growth centre.

The Act to establish the Regional Municipality of Durham (Bill 162) dissolved all planning areas that were included within the boundaries of the new municipality. However, the Act also stipulates that all existing official plans are to remain in effect until amended or replaced by new plans to be adopted by the Regional Council.

On November 14, 1973, the Council of the former Township of Darlington, within which the site is located, adopted Amendment No. 8 to the Official Plan of the Darlington Planning Area. This amendment is still before the Ministry of Housing for approval. It is designed to guide development within the boundaries of the former Planning Area until 1976, when a Regional Official Plan is to be prepared for the new Regional Municipality of Durham.

Proposed Amendment No. 8 anticipates considerable pressures for urbanization in the Courtice, Mitchell Corners and Bowmanville areas (Figure 6-9). However, full municipal piped services will be required before any extensive development can proceed. Also, a number of potential estate residential areas have been designated in rural areas due to an existing demand for such development.

On April 2, 1973, the Ministry of Treasury, Economics and Intergovernmental Affairs approved a new Official Plan of the Bowmanville Planning Area for the purpose of guiding growth during the period up to 1986. This plan is designed basically to meet the needs of an anticipated population growth to about 15,000 by 1986. Although the availability of large amounts of accessible industrial land pose immediate prospects for higher industrial employment in this urban centre, the plan recognizes that the centre will probably continue to serve primarily as a dormitory for Oshawa.

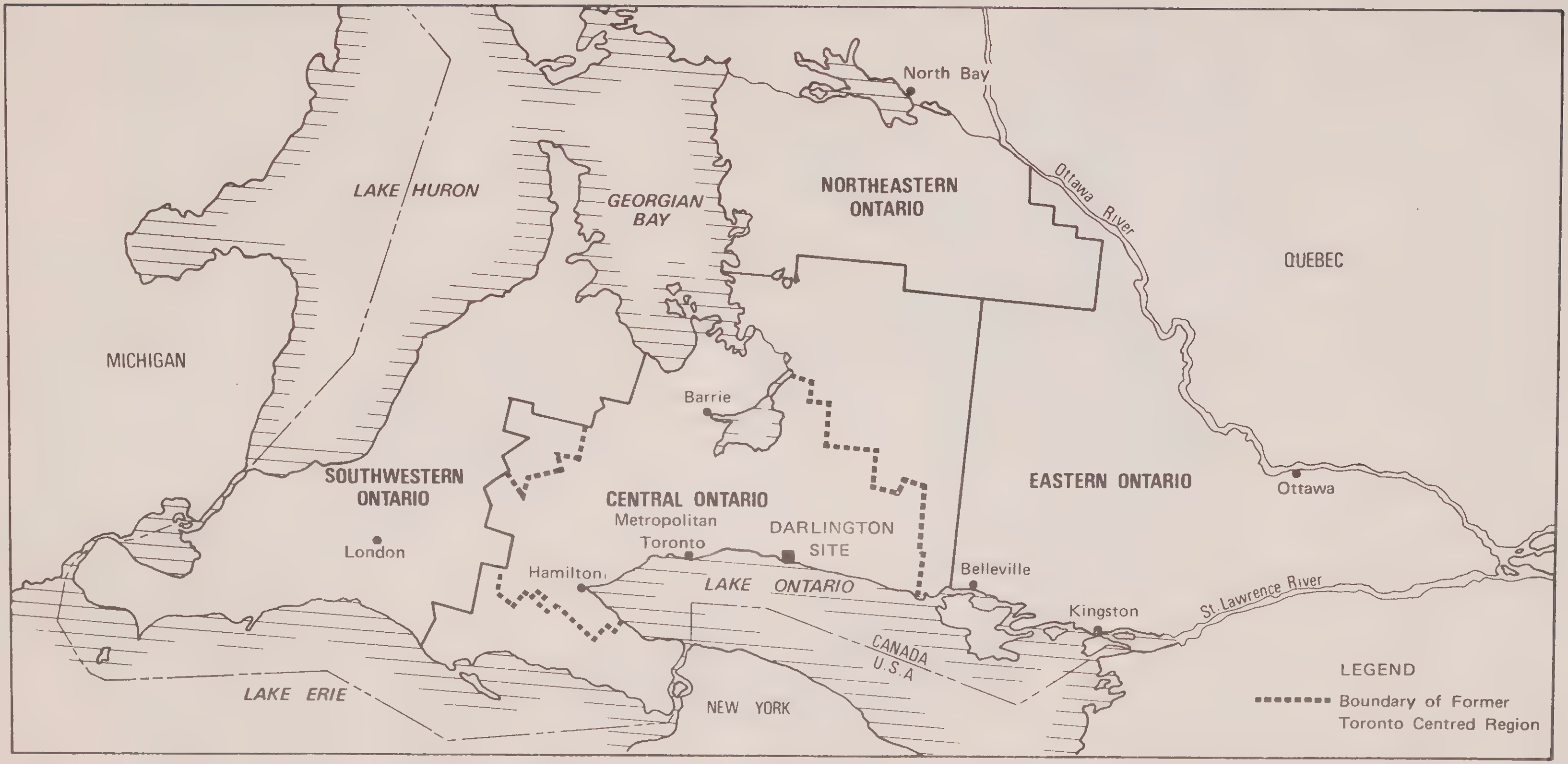


FIGURE 6–8 PROVINCE OF ONTARIO PLANNING REGIONS

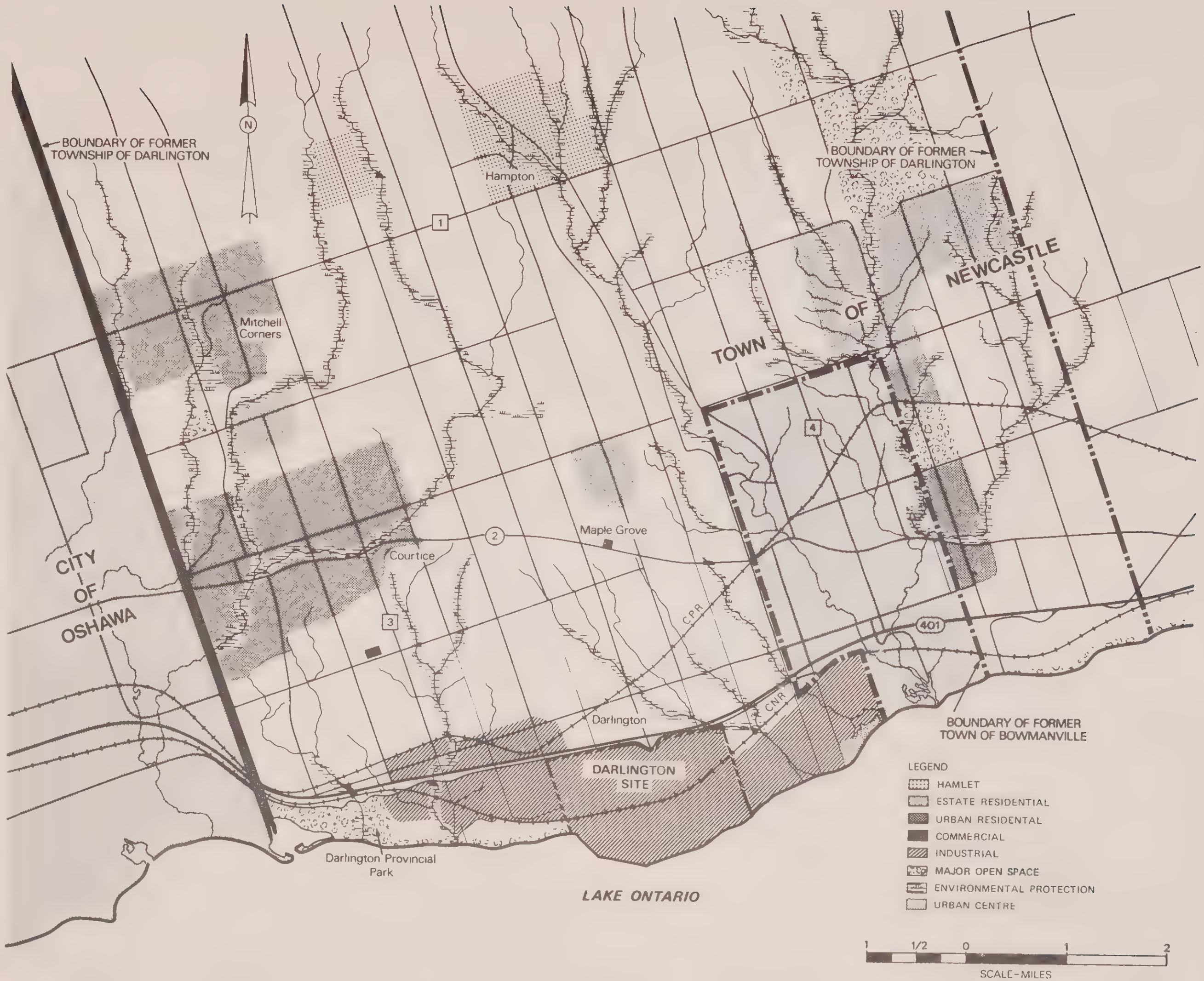


FIGURE 6–9 PLANNED LAND USE

This plan also points out that the existing sewage treatment system is designed to serve a population of 15,000 and will have to be expanded when this population is exceeded.

It is now anticipated that when the subdivisions either already approved or under construction are completed by 1977-78, the 15,000 population figure will have been reached.

The community of Newcastle has no approved Official Plan but does have a Restricted Area By-Law to regulate land use. There have been several proposals by developers and landholders for major housing construction programs in this community, including some on lands now designated for rural use by the above By-Law. These have been hampered by the lack of an Official Plan for the community and by insufficient sewage treatment and water supply facilities to handle the increased demand.

According to a 1973 Water Supply Study (31) for the former Village of Newcastle, an Official Plan has been drawn up in draft form. It calls for a natural (gradual) growth rate of population in the community recognizing that the water demand to be generated by large scale housing construction projects would far exceed the capacity of existing and potential groundwater supplies. The Water Supply Study recommends that if any additional water supply is required, Lake Ontario is the best source. However, complete treatment would be required. The same study describes the sewage treatment plant, presently under construction, as having an ultimate design capacity to serve 5000 persons.

In 1973, the Council of the former Township of Clarke adopted an Official Plan for the Clarke Planning Area (still before the Ministry of Housing for approval). The purpose of this proposed plan is to provide a framework within which to control further development in the Planning Area. One major objective of the plan is the confinement of new, large-scale residential development to those areas that already have community facilities, the capability of economic servicing by public utilities, and the encouragement of economic and commercial activities. Furthermore, the taxation revenue from any new development must be sufficient to compensate for generated costs.

This plan has designated an area west of the Orono community as a "Special Policy Area" in which single-family, low-density development will be allowed, subject to approval by regulatory agencies. Also, a limited amount of estate residential development (2-acre minimum lot size) will be allowed in rural areas.

Also in 1973, the Council of the City of Oshawa adopted an Official Plan of the Oshawa Planning Area (awaiting approval by the Ministry of Housing) to guide further urban development. Objectives of the Plan include ensuring compatibility of adjacent land uses, proper distribution of types and intensity of new development such that they conform to regional planning objectives and place no burden on transportation and servicing systems, and avoiding adverse effects on the environment by the development and operation of land uses.

6.4.2 Population

Figure 6-10 identifies the urban areas within 25 miles of the site. Permanent population estimates for 1971 and predictions for 1986 and 2001 are presented in tabular form. These are listed for intervals of 5-mile radii from the site.

The 1971 population estimates are based on the 1971 Census of Canada using enumeration area populations provided by the Ontario Statistical Centre of the Ministry of Treasury, Economics, and Intergovernmental Affairs.

Figure 6-10 presents the forecasted population distribution within a 25-mile radius of the site for the years 1986 to 2001. These estimates were based on projected capacities as given by the Metropolitan Toronto Planning Board(32), populations for the year 1981 projected by the Metropolitan Toronto Transportation Plan Review(33), populations for the year 2001 projected by the Oshawa Area Planning and Development Study(34), and population projections to the year 2000 by the Proposed Official Plan of the Oshawa Planning Area(35).

6.4.3 Industry

Proposed Amendment No. 8 to the Official Plan of the Darlington Planning Area(36) designates most of the land area along the Lake Ontario shoreline between the Bowmanville community and Darlington Provincial Park for industrial use, Figure 6-9. A large cement plant and quarry already adjoin the eastern boundary of the Darlington site.

Industry in the Bowmanville community has primarily been in the form of light to medium manufacturing. The two largest plants produce rubber products and iron castings respectively.

The City of Oshawa has become a major centre of heavy manufacturing activity with approximately 90 manufacturing plants employing over 20,000 people. The largest segment of this employment is associated with the automobile manufacturing industry.

A preliminary survey has determined that there are no producing natural gas wells within 25 miles of the site. Furthermore, sand and gravel are the only minerals that are extracted from the earth within the 25-mile zone.

6.4.4 Agriculture

The general area in which the site is located has developed a trend toward rapid urbanization, as housing shortages and high prices in the large centres of Toronto and Oshawa have forced people to relocate elsewhere and commute to work. This trend is causing a gradual

reduction in farmland as increasing property values make subdivision development a more economically feasible venture.

Agricultural data for 1971 was provided by the Economics Branch of the Ontario Ministry of Agriculture and Food, and is listed in Tables 6.17, 6.18, 6.19.

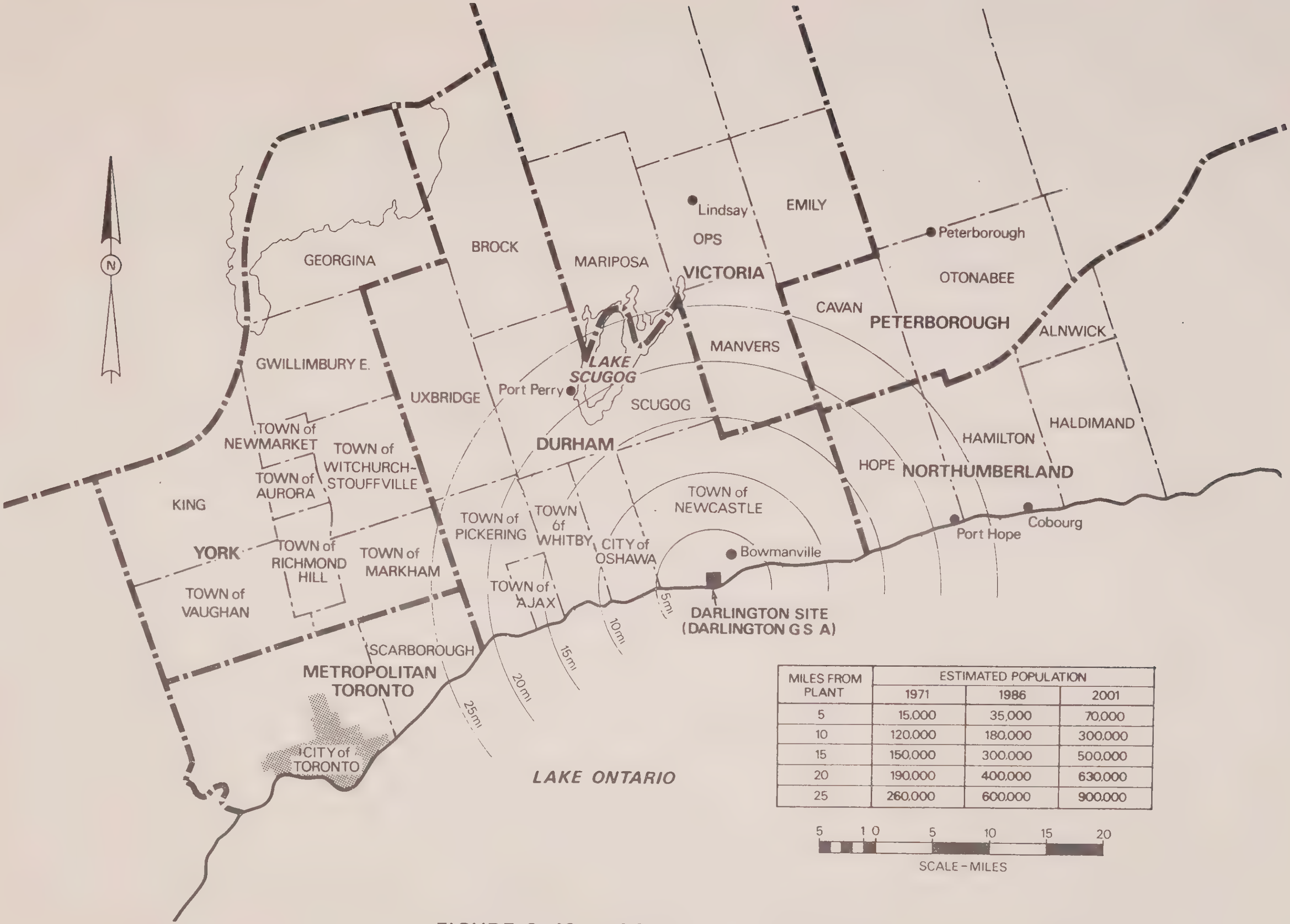
TABLE 6.17

AGRICULTURE

Agricultural Land Use
Within 5, 10 and 15-Mile Radii of Site

1971 Census of Agriculture

Land Use	0-5 Miles (acres)	0-10 Miles (acres)	0-15 Miles (acres)
Cropland	5976	23889	44807
Summer Fallow	328	626	1379
Improved Land For Pasture	1569	7138	15518
Other Improved Land Area	321	1205	2364
Total Improved Land Area	8192	32856	64068
Woodland	368	2867	7457
Other Unimproved Land Area	1666	7192	17772
Total Unimproved Land Area	2034	10060	25229
Total Farm Area	10227	42917	89295



MILES FROM PLANT	ESTIMATED POPULATION		
	1971	1986	2001
5	15,000	35,000	70,000
10	120,000	180,000	300,000
15	150,000	300,000	500,000
20	190,000	400,000	630,000
25	260,000	600,000	900,000

FIGURE 6–10 POPULATION PROJECTION

TABLE 6.18

AGRICULTURE

Acreage of Selected Crops
Within 5, 20 and 15-Mile Radii of Site

1971 Census of Agriculture

Crops	0-5 Miles (acres)	0-10 Miles (acres)	0-15 Miles (acres)
Spring Wheat	15	65	99
Winter Wheat	67	252	523
Oats for Grain	443	1723	3494
Barley	193	1092	2243
Rye	4	110	342
Total Mixed Grains	722	3181	6608
Dry Field Peas & Beans	138	188	189
Corn for Grain	833	3258	5407
Corn for Silage	351	2489	4528
Alfalfa & Alfalfa Mixtures	732	4764	11087
Other Tame Hay	1175	3241	5857
Oats for Hay	33	179	317
Soybeans	103	124	134
Potatoes for Sale	13.6	26.2	48.8
Tobacco	14.9	218.9	450.3
Fruit Trees	365.4	1465	1647
Small Fruit	15	29.8	41.1
Total Vegetables	748.8	1240.3	1385.1

TABLE 6.19

AGRICULTURE

Selected Livestock & Poultry
Within 5,10 and 15-Mile Radii of Site

1971 Census of Agriculture

Stock	0-5 Miles (number)	0-10 Miles (number)	0-15 Miles (number)
Total cattle and calves	2386	11448	22682
Cows & heifers, 2 yrs & over	1319	5404	9968
Heifers, 1 yr & under 2	373	1718	3640
Steers, 1 yr & under 2	141	1724	3456
Bulls, 1 yr & over	31	130	280
Calves, under 1 yr	524	2470	5337
Cows & heifers (raised for milk)	774	3360	5655
Heifers, 1 yr & under 2 (raised for milk)	281	1035	1839
Total beef cows	546	2044	4312
Total pigs (all ages)	1733	5724	9736
Total sheep & lambs	426	1619	2693
Rabbits	106	408	1317
Total chickens pullets	142082	430447	500207
Total hens for egg production	56891	140019	183043
Mink	1219	26855	29175
Horses & ponies	111	410	758

6.4.5 Labour Market

The site is located on the eastern fringe of the "Golden Horseshoe" of communities along the northwest shore of Lake Ontario. This region is the industrial centre of Canada and, consequently, has the largest concentration of skilled labour in the country.

6.4.6 Education

Portions of two Educational Regions are included in a 25-mile radius of the site. The director of Region 9, Eastern Region has jurisdiction over the new Town of Newcastle and the Counties of Northumberland and Peterborough. The director of Region 8, East Central Region has jurisdiction over the rest of the Regional Municipality of Durham, Metropolitan Toronto, and the Regional Municipality of York.

The school board within whose jurisdictional boundaries the site is located has recently been renamed to the Northumberland and Newcastle Board of Education. It includes the County of Northumberland and the new Town of Newcastle.

In the 1972/73 school year, there were 22 public schools, 3 secondary schools, 1 separate school and 1 school for the trainable retarded in the new Town of Newcastle.

6.4.7 Medical

According to the 1973 Canadian Hospital Directory, the nearest hospital to the site is Bowmanville Memorial Hospital in the community of Bowmanville, having a medical/surgical capacity of 88 beds. A greater variety of services are provided at Oshawa General Hospital in the City of Oshawa, which has a medical/surgical capacity of 325 beds.

6.4.8 Transportation

The general area of the site is well served by transportation facilities. These include two provincial highways, a railway, a regional airport and Lake Ontario.

The MacDonald-Cartier Freeway (M/C Freeway) and Highway 2, both serve the area. Municipal roads then provide direct access to the site. The M/C Freeway has two interchanges nearby: one about two miles to the east, and the other the same distance to the west of the site. These interchanges connect to a paved, two-laned, light-service road which intersects with another local road that provides access to the site (Figure 6-11).

The area is also served by the Canadian National Railway line south of and parallel to M/C Freeway. This line bisects the Darlington property.

6.4.9 Recreation and Parkland

6.4.9.1 Present

The main recreational facility of the area is the 380-acre Darlington Provincial Park immediately southeast of Oshawa and three miles west of the proposed station site. It is a popular facility, having had over 215,000 visitors in 1972. It features 368 campsites, swimming facilities, fishing, controlled hunting, boating, etc.

Also, within 25 miles of the site are eleven Conservation Areas: three within the Metropolitan Toronto and Region Conservation Authority, four within the Central Lake Ontario Conservation Authority and four within the Ganaraska Conservation Authority (Figure 6-12).

In addition to these facilities, there are numerous golf courses, local parks, swimming areas and snowmobile trails. A 45-acre zoo is located within the community of Bowmanville.

There are no provincial wildlife sanctuaries within 25 miles of the site. There are, however, three wildlife management areas (controlled hunting) including one in Darlington Provincial Park (Figure 6-12).

For a complete listing of recreational facilities within 25 miles of the site, refer to Table 6.20.

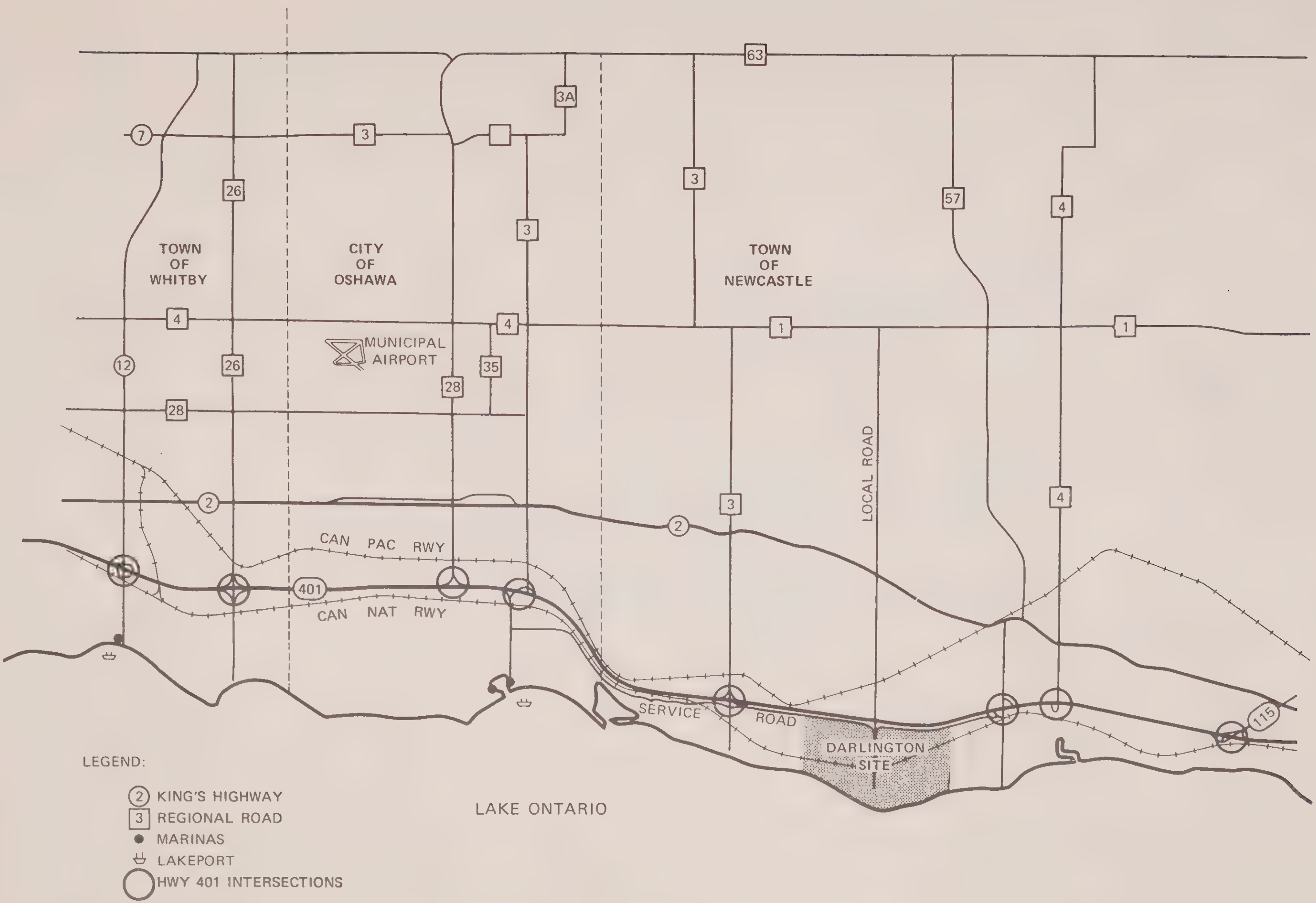


FIGURE 6–11 TRANSPORTATION

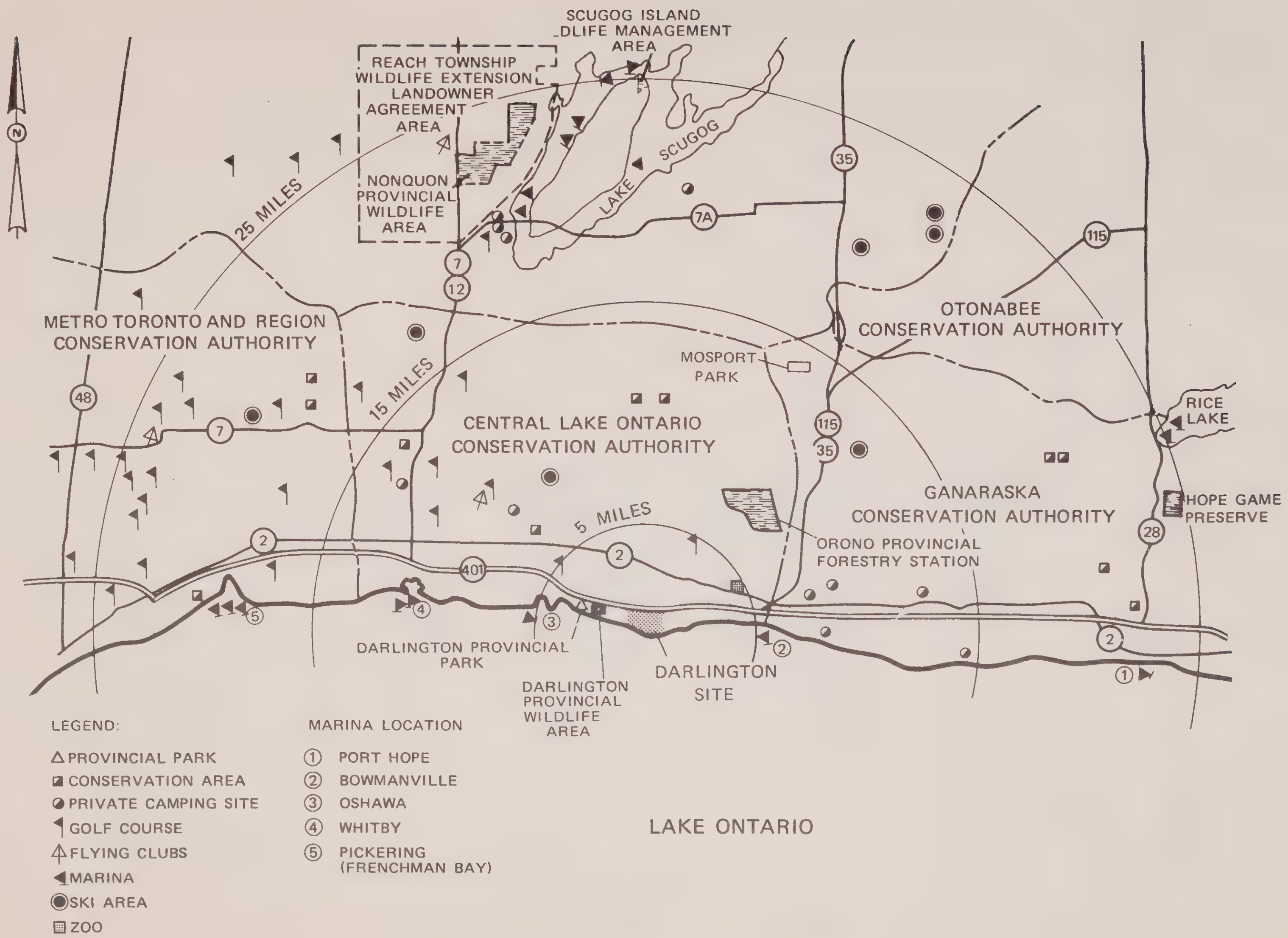


FIGURE 6–12 RECREATIONAL AREAS

TABLE 6.20

RECREATION AREAS WITHIN 25 MILES OF THE PROPOSED PROJECT

Distance (mi.)	Description
0-5	Aldian Snowmobile Hill Bowmanville Zoo Darlington Provincial Park Erinli Golf and Country Club
6-10	Bowmanville Country Club Enniskillen Conservation Area Harmony Valley Conservation Area Newcastle Golf Course Newcastle Trailer Park Oshawa Golf Course Oshawa Yacht Haven Oshawa Municipal Airport Samac Camp (Boy Scouts Canada) Waltona Park
11-15	East Shore Marina Fantasyland Park Heber Down Conservation Area Kendal Recreation Area Long Sault Conservation Area Marydale Park Mosport Park Oshawa Kirby Ski Club
16-20	Annandale Country Club Birdseye Centre Park Cherry Downs Golf Club Claremont Conservation Area Dagmar Ski Club Dean Hill Conservation Area Garden Hill Conservation Area Goreski's Summer Resort Greenwood Conservation Area Island Marina Keen Kraft Marina Lake Scugog Marina Lower Rouge Conservation Area Poplar Park Scugog Camp (United Church Canada) Sylvan Glen Conservation Area Thunderbird Golf and Country Club

TABLE 6.20 (cont'd)

RECREATION AREAS WITHIN 25 MILES OF THE PROPOSED PROJECT

Distance (mi.)	Description
21-25	Beacon Marina
	Beverly Park
	Blue Heron Park
	The Caribou
	Coppins Marina
	Dalewood Golf and Curling Club
	Devils Elbow Ski Area
	Durham-Ganaraska County Forest
	Glen Cedars Golf Club
	Greenbank Airport
	Lake View Camp
	Lakeview Marina
	Merry Mac's Camp
	Millbrook Provincial Fishing Area
	Moodies Trailer Park
	Moore Haven Marina
	Mountain's Marina
	Nonguon Provincial Wildlife Area
	Pickering Golf Club
	Pleasant View Marina
	Poplar Inn Marina
	Port Hope Conservation Area
	Reach Township Wildlife Extension Landowner Agreement Area
	Rice Lake Garage
	Skeena Marina
	Toronto Markham Airport
	Wallace Point
	Whitevale Golf Club

6.4.9.2 Future

A 200-acre addition is planned for Darlington Provincial Park for the near future. It would be located between the present west boundary of the park and Second Marsh in Oshawa. Facilities in the addition would be "urban-oriented" and include swimming pools and tennis courts. Second Marsh would be designated as a bird sanctuary.

The proposed Official Plan of the Clarke Planning Area indicates that a new 2 to 5-acre neighbourhood park is planned for the community of Newtonville approximately 14 miles east of the site.

6.4.10 General Land Use

6.4.10.1 Site

Almost all of the land within the site boundary is rated as having Class 1 soil, with no significant limitations for use in crop production (44). With good management practices, soils under this classification are moderately high to high in productivity for a wide range of field crops. A small portion of the site, near the west boundary, is located in an area that has 70% Class 1 and 30% Class 3E soils. The latter classification identifies soils that have moderately severe limitations restricting the range of crops or requiring special conservation practices due to past erosion damage.

The shoreline of the site is rated as having moderately low capability for outdoor recreation, and the remainder of the property as having only a low capability for such activity (45).

A field investigation of present land use within the site boundaries was carried out by Ontario Hydro in June 1974. Observed general land use is indicated in Figure 6-13. The field survey indicated that, at present, almost half of the site area is in pasture for cattle. The remaining portion of land is either under cultivation, wooded, or allocated to small orchards. There are approximately 20 houses presently on the site property, the majority of which appear to be in good repair. Several farm buildings are found with some of these houses.

6.4.10.2 Transmission System

The subject of the transmission system has been separately examined by the Solandt Commission.

6.5 NOISE

To the north of Darlington GS A, where the property line is situated near the MacDonald-Cartier Freeway, the normal traffic noise will

greatly exceed the noise emanating from the plant. To the east and the west of the station, the property line is situated about a mile away in either direction. The presently existing normal background noise levels at this line would probably average about 40-45 dbA during daytime and 35-40 dbA during nighttime.

6.6 STUDIES IN PROGRESS

6.6.1 Radioactive Emissions

A pre-operational monitoring program has as yet not been fully established. The pre-operational surveys planned for the site include the monitoring of baseline radiation and radioactivity levels as well as their seasonal variations. Also included are surveys of the local environment and population to establish critical exposure pathways, critical groups and to help select appropriate sampling media for the post-operational monitoring program.

6.6.2 Non-Radioactive Emissions

During and after site acquisition, preliminary studies of biological, water quality, hydrological and geological conditions were carried out in the area which was expected to be occupied by the proposed generating station and the thermal discharge from it. The data from these studies, together with data from studies carried out at other sites or existing stations on Lake Ontario, have been incorporated in this document of the site area. The object of studies during the conceptual design and preliminary engineering phases of the project development will be to obtain further environmental data which may influence design and operation of the station. It is expected that a pre-operational study phase will start approximately three years before the first unit is scheduled to come into service in order to provide baseline information for comparison with post-operational conditions.

In conjunction with the concept to develop uses for the warm water discharge from the station (Section 9.3), an aquatic biological program is now being carried out to determine the potential Cladophora growth problem and the changes in shoreline productivity.

5.0 LEGAL REQUIREMENTS

5.1 RADIATION EXPOSURE REGULATIONS

The Atomic Energy Control Board (AECB), a federal agency, was created in 1946 by the Atomic Energy Control Act as the regulatory agency for atomic energy in Canada. The AECB reference dose limits for exposure of the public have been outlined (1, 2, 3, 46). These limits are based on recommendations by the International Commission on Radiological Protection (ICRP).

At the provincial level, "radiation" is one of the contaminants whose release may be subject to provincial review as outlined in the amended Environmental Protection Act, 1971, (Ontario) (4). However, there is no direct authority at the provincial level for regulating, restricting or prohibiting the installation, use, handling, maintenance, storage or disposal of potential sources of radiation.

At the international level, the International Joint Commission (IJC) refers to radioactive materials as a possible pollutant (5).

The radiation dose limits for members of the public, as set by the AECB and recommended by the ICRP, are given in Table 5.1.

TABLE 5.1

RADIATION DOSE LIMITS

Organ	Annual Dose Limits (rem)
Whole-Body, Gonads, Red Bone Marrow	0.5
Skin, Bone, Thyroid	3.0*
Other Single Organs	1.5
Extremities	7.5

*The dose to the thyroid of a person under the age of 16 years shall not exceed 1.5 rem/year.

These limits apply to the combined total of normal plus abnormal releases from an operating nuclear station. "Abnormal" refers to releases arising from single failures in the essential process equipment. The frequency of failures in the essential process equipment that would result in a significant release of fission products from the equipment if the protective devices fail to operate, should not exceed once in three years (2).

The AECB further limits the population dose to:

(i) 10^4 man-rem per year to the whole body

and (ii) 10^4 thyroid-rem per year per site.

For gaseous radioactive releases, the integration of population dose extends over all areas outside the exclusion area in which the external individual dose exceeds 5 millirem/year, or the individual thyroid dose exceeds 30 millirem/year, or the areas out to 10 miles, whichever is greater. The exclusion area is the area around a station which is within approximately one kilometer (3,000 feet) of the nearest reactor building.

The dose limits set by the AECB are not regarded as design targets but are regarded as maximum limits which must not be exceeded. The ICRP recommendation that all exposures be kept as low as practicable (6) is supported by the nuclear industry in Canada.

5.2 AIR QUALITY

5.2.1 Federal (Radiological)

The amount of radioactive airborne material that may be released from a nuclear station to the atmosphere is governed by the maximum dose limits set out by the AECB (see Section 5.1). It is necessary to convert these limits, which are given in rem, to some other basis which will be more useful to the station designer and operator. Following AECB and ICRP recommendations (7, 8), dose conversion factors have been produced which relate dose limits in rem to maximum permissible concentrations in air (MPC_a) for continuous exposure. The dose conversion factors take into account various factors such as most susceptible individual organs, method of uptake, etc. In Table 5.2, which lists MPC_a, a critical uptake pathway is through the food chain. Children, who drink large quantities of milk, are the limiting group for the concentration of several radio-isotopes in the air over farm land.

TABLE 5.2

MAXIMUM PERMISSIBLE CONCENTRATION IN AIR (MPC_a) FOR CONTINUOUS INTAKE

Radionuclide	External Irradiation $\frac{\gamma Ci\text{-}MeV}{m^3}$	Inhalation	Food Chain (Milk)
		Ci/m^3	
(1) Noble Gases	6.4×10^{-8}		
(2) I-131		3×10^{-11}****	6×10^{-13}*******
(3) H-3		3×10^{-7}	
(4) Particulates:			
Cs-137		1.5×10^{-9}	5×10^{-11}
Cs-134		1×10^{-9}	1.5×10^{-11}
Sr-90		4×10^{-11}	1.5×10^{-12}
Sr-89		2×10^{-10}	1.5×10^{-11}
Co-60		9×10^{-11}	
Ru-106		4×10^{-11}	
Unidentified** Particulates		4×10^{-11}	1.5×10^{-12}

* Assumes 50% of the dose is from the shorter-lived radioiodines accompanying I-131.

** The lowest MPC_a value under 'particulates' is used as the MPC_a for unidentified particulates. Measurement of unidentified particulate activity in the stack effluent will be based on the counting efficiency for Cs-137.

*** Based on a dose to a child's thyroid of 1.5 rem/year.

**** Assumes open field grazing 6 months per year.

The figures in Table 5.2 are based on the assumption that only one isotope is present at any one time; if several isotopes are present, their combined effect must be considered. Similarly, there may be other sources of radioactivity such as drinking water, edible fish, etc., that may contribute to the overall dose received. In addition, the MPC apply beyond the site boundary regardless of the number of radioactive waste emitting installations located there. More extensive information is given elsewhere (9). It must be emphasized that the above values represent the legal maximum permissible concentrations of radionuclides in respirable air available to the public on a continuous basis.

For design purposes, the MPC_a must be converted to Derived Release Limits (DRL). The DRL have units of curies per unit time and they are the best estimate of the maximum permissible average release rates if compliance with the maximum permissible dose limits for the public is to be ensured. The basis for the derived release limits for both airborne and liquid effluents from Ontario Hydro nuclear generating stations during normal operation takes into account the total release resulting from continuous, low level releases; from controlled, short-term releases; and from short-term releases resulting from any routine failures of process equipment (9). The following formula indicates the relationship between DRL during normal operation and the maximum permissible concentrations of radionuclides in air available to the public:

$$C = KQ$$

where: Q is the release rate (Ci/sec)

C is the concentration at a given distance from the source (Ci/m^3)

K is the dilution factor (sec/m^3)

The dilution factor K is a function of the distance from the source, the effective height of release, the weather, and the averaging time i.e., the time over which it is measured. Methods of estimating effective stack height and atmospheric dilution, taking into account atmospheric stability, have been developed by the U.K. Atomic Energy Authority (10). The averaging time adopted by Ontario Hydro for calculating permissible release rates is one week.

5.2.2 Federal (Non-Radiological)

The Federal Department of the Environment is responsible for enforcing regulations under the Clean Air Act, 1971, relating to ambient air quality and control of air pollution in Canada. The Act, limited in scope by the provisions of the British North America Act, is designed to assist provincial agencies in maintaining desirable ambient air quality.

5.2.3 Provincial

The provincial Ministry of the Environment is responsible for enforcing regulations under the Environmental Protection Act, 1971, to attain desirable air quality in the province.

The operation of a power generating station must meet legal requirements regarding atmospheric emissions. Legal requirements for radioactivity emissions at the Darlington site are promulgated at the federal level. However, the fossil fuelled combustion turbines for the standby generators do emit air pollutants which come under provincial jurisdiction. These requirements may include any or all of the following as defined under the Environmental Protection Act, 1971, by the Air Pollution Control Act, 1967, and its amendments.

(a) Standards for concentrations of air contaminants at point of impingement.

(b) Criteria for ambient air quality.

(c) Regulations on plume opacity.

(d) Regulations to prevent discomfort to persons, loss of enjoyment of normal use of property, interference with normal conduct of business or damage to property.

Incinerators are also regulated by the ministry and must be operated in an approved manner with any control equipment deemed necessary by the agency.

Desirable levels of certain contaminants have been set out in the legislation as criteria for ambient air quality. Impingement levels of contaminants emitted from sources are also set out in the regulations so as to achieve and maintain these ambient levels.

5.2.4 International

Canada and the United States, through the International Joint Commission, confer on transboundary emissions. This commission has no power of enforcement, but makes recommendations where international boundary problems exist.

5.3 WATER QUALITY

5.3.1 Federal Regulations

5.3.1.1 Radiological

The amount of radioactive liquid material that may be released from a nuclear station to a water body is governed by the maximum dose limits set out by the AECB (Section 5.1). The two main exposure pathways to man are by drinking water and consuming fish containing various radionuclides.

Quantity limits on a yearly basis for each radionuclide from all streams will be established for the station as a whole and will be determined as the product of the maximum permissible concentration of the radionuclide in the cooling water flow and the annual average cooling water flow, specified in the operating license. This quantity limit will become the station Derived Release Limit upon which the design target of 1% DRL will be based.

Maximum permissible concentrations of radionuclides in the station discharge have been specified based on the legal dose limits. Various factors such as the most critical group, uptake mechanisms, probable consumption, etc., have been taken into account in relating dose limits to MPC (11). Table 5.3 indicates the maximum permissible concentrations of radionuclides in water available to, or accessible by the public.

TABLE 5.3

MAXIMUM PERMISSIBLE CONCENTRATIONS IN WATERS AVAILABLE TO THE PUBLIC

Radionuclide	MPDI (μCi/day)	MPC_w* (μCi/ml)	MPC_{fw} (μCi/ml)
I-131	2.6×10^{-4}	3×10^{-7}	3×10^{-7}
H-3	4.5	5.5×10^{-3}	5.5×10^{-3}
Cs-137	2.2×10^{-2}	1×10^{-5}	4×10^{-7}
Cs-134	1.4×10^{-2}	6×10^{-6}	3×10^{-7}
Sr-90	8.8×10^{-4}	4×10^{-7}	3×10^{-7}
Sr-89	1.8×10^{-3}	2×10^{-6}	2×10^{-6}
Co-60	0.11	5×10^{-5}	1.5×10^{-5}
Ba-La-140	4.4×10^{-2}	2×10^{-5}	6×10^{-6}
Ru-106	2.2×10^{-2}	1×10^{-5}	3×10^{-6}
Zr-Nb-95	0.13	6×10^{-5}	8×10^{-6}
Xe-144	2.2×10^{-2}	1×10^{-5}	3×10^{-6}
Zn-65	0.22	1×10^{-4}	3×10^{-6}
Fe-59	0.13	6×10^{-5}	2.5×10^{-6}

* Critical group for I-131, H-3, and radiostrontium is the infant; critical pathway is drinking water (I-131 limit based on a dose of 1.5 rem/year to child's thyroid).

MPDI - maximum permissible daily intake

MPC_w - maximum permissible concentration in water used only for drinking

MPC_{fw} - maximum permissible concentration in water used for drinking and from which fish are caught for human consumption.

The average radionuclide concentrations in the station effluent on a monthly basis should not exceed the MPC_{fw} given in Table 5.3. Short-term concentrations averaged over a short period should not exceed ten times these values. For cases where several unidentified radionuclides are released, the MPC_{fw} for the most restrictive radionuclides, 3×10^{-7} µCi/ml, will be used as the average effluent MPC_{fw} for gross beta-gamma activity.

It must be noted that for the situation where an individual lives near a nuclear station he may receive a small radiation dose from a number of sources, e.g., inhalation, food consumption, drinking water. In this case, the total dose received must be less than the legal limit specified by the AECB.

5.3.1.2 Non-Radiological

The federal government may enact legislation on discharges to water and resulting water quality by virtue of its responsiblity for international and interprovincial waters and fisheries. The Canada Water Act, 1970, provides for the establishment and operation of federal - provincial water quality management areas. The Act prohibits the disposal of waste, including heat, into water in any given management area except in quantities under conditions prescribed by the regulations. However, no regulations concerning thermal discharges have been made under the Act.

A 1970 amendment to the Fisheries Act, 1952, prohibits the deposition of any wastes in waters, including heat, which will degrade the water quality. Under this Act, the Department of Fisheries and Forestry may enquire into a company's plans for expansion and can demand modifications to its anti-pollution measures if considered necessary to protect the fisheries waters.

Disposal of dredgings in the lake falls under the provisions of the Navigable Waters Protection Act, 1970, which is enforced by the federal Ministry of Transport. An application by Ontario Hydro to dredge and dump will be referred back to the Ontario Ministry of the Environment and the Ministry of Natural Resources to determine if the proposed dumping procedure will have any adverse environmental effect. Depending on the assessment by these two provincial ministries, the Ministry of Transport may then issue a license to dredge and dump.

5.3.2 Provincial Regulations

The main body of provincial legislation for controlling discharges to water and the resulting water quality and biological effects is contained in the Ontario Water Resources Act. This Act gives the Ministry of the Environment the authority to supervise all surface and ground waters in Ontario. With respect to discharges, Section 30 states:

"Under sections 31, 32, 34 and 36, the quality of water shall be deemed impaired if, notwithstanding that the quality of the water is not or may not become impaired, the material deposited or discharged or caused or permitted to be deposited or discharged or any derivative of such material causes or may cause injury to any person, animal, bird or other living thing as a result of the use or consumption of any plant, fish or other living matter or thing in the water or in the soil in contact with the water."

The Ministry of the Environment outlines its criteria in the publication - "Guidelines and Criteria for Water Quality Management in Ontario". These guidelines and criteria do not have force of law, but there are legal procedures under the Act for enforcing compliance. In addition to adhering to these objectives, Ontario Hydro will consult with the Ministry of the Environment and submit applications for permits or approval for specific aspects of the proposed project which may have water quality implications. These include:

(a) The maximum allowable temperature rise between intake and discharge in the condenser cooling water. It is recognized that the Ministry of Environment guidelines require that this temperature difference at the proposed station should not exceed 20F^{o} and that the exit temperature of the discharge water should not exceed 90^{o}F.

(b) The volume of cooling water to be used including that used for any tempering.

(c) A prediction of the area of the receiving body to be occupied by the heated discharge under various climatological conditions.

(c) Emissions to water with respect to possible biological changes or influences.

(e) Miscellaneous discharges, e.g., from the water treatment plant, boiler blowdown and site drainage.

(f) Water quality during dredging and dumping operations.

(g) Batch releases of boiler treatment chemicals during the commissioning period.

Contingency planning, for inadvertent discharges or spills, will be provided for in the environmental project requirements and will be based on the Ontario Hydro Management Guide No. M-19-0, Ontario Water Pollution Legislation Guidelines for Conformity, February 1974.

The Ministry of Natural Resources can enforce the Lakes and Rivers Improvement Act and some provisions of the federal Fisheries Act within the province. In practice, there is consultation between the Ministry of the Environment and the Ministry of Natural Resources, both of which have concern over the effects of discharges to the aquatic environment.

5.3.3 International

5.3.3.1 International Joint Commission - Radioactivity

The International Joint Commission (IJC) is a body which investigates, recommends and attempts to coordinate monitoring and surveillance activities on the quality of the boundary waters shared by the United States and Canada. The IJC discharges its function under the Boundary Waters Treaty of 1909. Proposals for specific objectives regarding radioactivity levels in receiving waters have been made (12). Ontario Hydro effluent radioactivity levels will conform to these proposals once they are ratified.

5.3.3.2 International Joint Commission - Conventional Water Quality

Proposals for water quality objectives were issued in 1970 by the International Joint Commission (IJC), for Lake Erie, Lake Ontario, the International Section of the St. Lawrence River and the connecting channels of the lower Great Lakes. In these proposals, the objective is that no heat discharge should be allowed which would adversely affect any local or general use of these waters. The IJC recommended that its programs and measures to achieve its objectives be agreed to by the Governments of Canada and the United States. It also recommended that appropriate government agencies be involved in site selection and consulted in the design of thermal plants in order to minimize any adverse effects of temperature changes in the receiving waters. The IJC further suggested an extension of its existing authority to promote the implementation of its objectives.

There has been recent formal agreement between the Governments of Canada and the United States to give force of law to certain IJC proposals.

5.4 SOLID WASTES

5.4.1 Radioactive Solid Wastes

The Atomic Energy Control Act contains regulations which govern the safe handling and transportation of radioactive materials, but there are no specific regulations governing the management of radioactive waste, although waste management practices have been reviewed and authorized by the AECB. Ontario Hydro has developed a set of waste management regulations for inclusion in the Ontario Hydro Radiation

Protection Regulations. The basic philosophy of the regulations is summarized by the first of the waste management principles, namely:

> "All radioactive wastes shall be managed such that the public, its environment, and its resources are protected against hazard".

Further principles regarding radioactive waste storage are:

> "Facilities intended for storage of radioactive waste shall be designed to prevent radionuclide releases to the environment", and "Radiation exposure to individual members of the public resulting from the operation of the waste management facility shall not exceed ... (the maximum dose limit specified by the AECB in Table 5.1)".

Once a suitable site for a radioactive waste management area has been found, and before any construction can begin, plans for the site and facility must be submitted to the AECB for its approval. When the AECB is satisfied that the site is suitable and that all appropriate measures have been taken to ensure that the general public and the environment are adequately protected, a construction permit will be issued. In order to operate the facility, the applicant must obtain an operating licence which is renewable at regular intervals provided satisfactory operating standards and environmental monitoring are maintained. The AECB has recently issued a guide for licensing of radioactive waste management facilities (43).

5.4.2 Non-Radioactive Solid Wastes

Collecting, transporting, processing and disposal of solid wastes during construction and operation are controlled by the provisions of the Environmental Protection Act, 1971. The two types of Certificates of Approval issued by the Ministry of the Environment are for Waste Management Systems and Waste Disposal Sites.

A Waste Management System Certificate of Approval is required for collecting and transporting of wastes. This Certificate of Approval is not required if Ontario Hydro uses its own vehicles on the property, but is required if public roads or if rented property is used. If handling is carried out by a contractor, he must take out the Certificate of Approval.

A Waste Disposal Site Certificate of Approval is required for each property where there is a disposal site. Waste from trash racks, on-site ash disposal and sewage lagoon residues require a Waste Disposal Site Certificate of Approval. For off-site disposal, site approval and a Waste Management System Certificate of Approval are also required. Oil disposal on roads requires a Waste Management System Certificate of Approval and the locations of intended disposal areas need to be stated.

Expansion of a system or site requires further application and hearings. The Certificates of Approval for a Waste Disposal Site or a Waste Management System expire one year after the approval date and must then be renewed.

Floating material removed by the travelling screens should not be returned to the water body but should be disposed of at an approved location. The Ministry of the Environment provides a water-use permit based on this requirement. In addition, under the provisions of the Environmental Protection Act, disposal of trash rack material must have a Certificate of Approval for the particular solid waste disposal system to be used. However, under the federal Fisheries Act, the provincial Ministry of Natural Resources is empowered to investigate cases where fish are removed from the water body, the Ministry's main concern being that fish should be returned in an unharmed condition.

5.5 NOISE

Noise originating from industrial and other sources and emanating to the surrounding community is presently receiving attention at the federal and provincial government levels. With the exception of municipal by-laws in some areas, legislation governing the noise levels at the industry-community property line are non-existent. One municipal by-law requires the noise levels not to exceed 45 dbA at the property line.

Although there is no unanimous agreement on the permissible noise levels at the industry-community property line, it is most probable that the upper limit, as set by the future legislation, would be below 40 dbA on a continuous noise basis and 50 dbA on an intermittent noise basis.

5.6 LAND USE ZONING

5.6.1 Site Area

The entire Darlington site, of which some parcels are still in the process of being acquired by Ontario Hydro, will ultimately contain about 1400 acres. Included are approximately 200 acres to be purchased in Lake Ontario waterlots, about 120 acres to be reclaimed.

The site is located within the former Township of Darlington. Proposed Amendment No.8 to the Official Plan of the Darlington Planning Area, adopted by the Council of the former Township of Darlington in November, 1973, is presently still before the Ministry of Housing for approval. This proposed Amendment designates the Darlington site for industrial use (Figure 5-1).

By-Law No. 2111 of the former Township of Darlington, as amended and still in effect, designates almost half of the area within the Darlington site for industrial use with the remainder allocated for

agricultural use. However, under the terms of the By-Law, these designations do not apply to the use of the land by Ontario Hydro.

5.6.2 Transmission System

The property for the transmission lines of the proposed station will be purchased or leased. The right-of-way may be used for agriculture or any other purpose compatible with the transmission right-of-way and local zoning bylaws.

5.7 PROJECT APPROVAL PROCEDURE

To obtain approval for the location of a proposed generating station on a particular site, Ontario Hydro must satisfy the provincial regulatory authorities regarding its environmental suitability. Data relating to all environmental considerations for a given project is compiled in an Environmental Assessment, which describes the existing environment at the site and the possible and expected environmental effects and community impact of both construction and normal operation of the proposed station. The Environmental Assessment is presented to the Minister of Energy who distributes it to the various ministries for comment. It is also made available to the public prior to public participation meetings where matters of concern or interest relating to the proposed station may be discussed. These matters are recognized to be the economic and social impacts of the project on the community, the recreational or industrial uses of lands and waters adjacent to the station, the operating and potential accidental releases of harmful substances to the environment and the aesthetic and other environmental effects of the project. These views and comments, where appropriate, in addition to those of the various Provincial Ministries will be incorporated in a Final Proposal for submission to the Minister of Energy for approval of the proposed project.

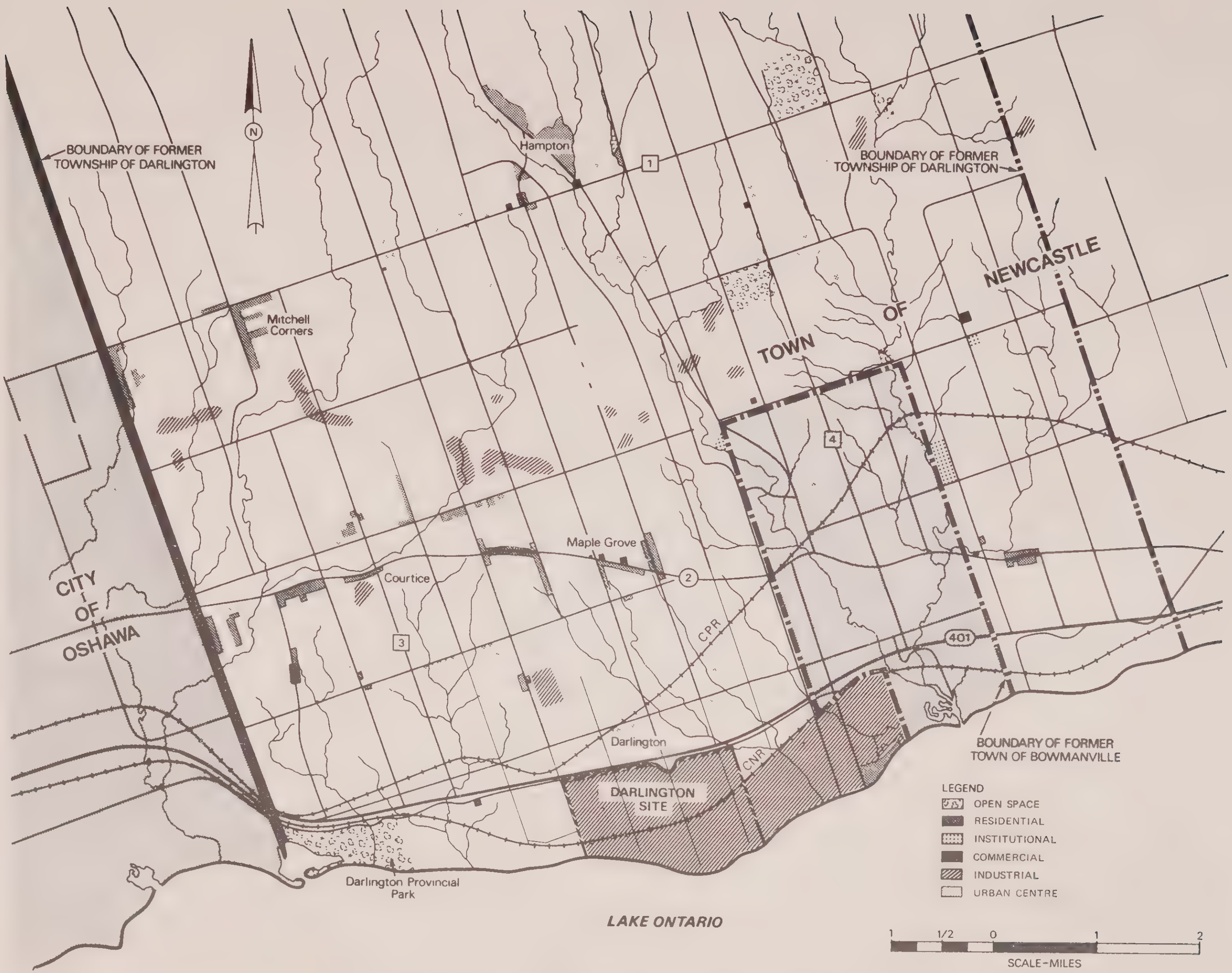


FIGURE 5–1 PRESENT LAND USE – DESIGNATED

6.0 EXISTING ENVIRONMENT

6.1 AIR

6.1.1 Quality

6.1.1.1 Radiological

Background external gamma radiation has been measured by Ontario Hydro at the Bruce Nuclear Power Development (BNPD) and at the Pickering sites. The level of background radiation is influenced by several factors such as geographic location, elevation and the time of year. Background radiation can vary as high as 150 millirem/year but at both the BNPD and Pickering sites the background radiation averages about 50 to 70 millirem/year with a natural variation of up to 10 to 20 millirem/year. The natural background gamma radiation at the Darlington site is not expected to be significantly different from these values.

Ontario Hydro plans to institute a comprehensive radiological monitoring program at the Darlington site in 1975 but until such time, no other pertinent radiological data for the site are available.

6.1.1.2 Non-Radiological

Air quality data are not available for the immediate area of the station, however, since the area is mainly rural, it is expected to be good. At the Wesleyville site 15 miles east, air quality has been monitored over a period of months and has been found to be good.

The St. Mary's Cement Plant, adjacent to the site, is the nearest industrial source of atmospheric emissions. The community of Bowmanville and the City of Oshawa, at three miles and six miles respectively, are the closest urban areas. Atmospheric emissions from these areas will have only a small effect on air quality in the immediate area of the site.

6.1.2 Meteorology

6.1.2.1 Climatology

Due to its shoreline location, the site will experience mesoscale variations in synoptic weather conditions. These include lake breeze effects and slight tempering of the wide air temperature range experienced inland. Climatological data are available from four observing stations: Toronto International Airport, Trenton Airport, Toronto Island Airport and Cobourg. The first two are first order climatological stations.

(i) Air Temperature

The severity of the temperature change with season is slightly tempered by the proximity to a large fresh water body. The air temperatures are generally cooler in summer and milder in winter than in areas further inland. In July, the mean daily range inland is 22-26F° compared to 18-20F° along the shoreline (13). The mean annual frost-free period is 160 days at the site, compared to 130 days approximately 40 miles inland.

Table 6.1 gives air temperature normals for Toronto Island Airport; these are considered sufficiently representative for use at the Bowmanville site.

(ii) Precipitation

The mean annual precipitation for the site is 32 inches, this is accounted for by 25.6 inches of rainfall and 64 inches of snowfall (13).

Annual evaporation is estimated at 30 inches (14). This rate is based on class A, evaporation pan data, used in the equation of Kohler et al, 1955 (15).

TABLE 6.1

TEMPERATURE NORMALS FOR TORONTO ISLAND AIRPORT, °F

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Temp	24.6	24.9	31.4	42.3	53.5	62.9	69.1	68.3	60.8	49.5	39.0	28.5	46.2
Ave. Max Temp	30.3	30.8	37.3	48.6	63.4	71.4	77.3	76.1	68.3	56.2	44.6	33.7	53.2
Ave. Min Temp	18.8	19.0	25.4	36.0	43.5	54.3	60.8	60.5	53.3	42.7	33.4	23.2	39.2

Highest Recorded Temperature 94
Lowest Recorded Temperature -12

6.1.2.2 Wind

Wind data have been collected for the past four years at the Wesleyville site (40), approximately 15 miles east along the shoreline. These data are representative of conditions at the Darlington site. Longer term data are available from more distant locations such as Toronto International Airport (41) and Trenton Airport (41). Data for wind direction and velocity for these three sites are summarized in Tables 6.2 and 6.3. Although all three locations show similar characteristics, the Wesleyville and Trenton data indicate few off-lake winds from the general south and southeasterly directions.

Figure 6-1 shows a wind rose for the site based on four years of record at Wesleyville. Winds are towards the land areas approximately 35% of the year. This frequency is expected to apply to the Darlington site.

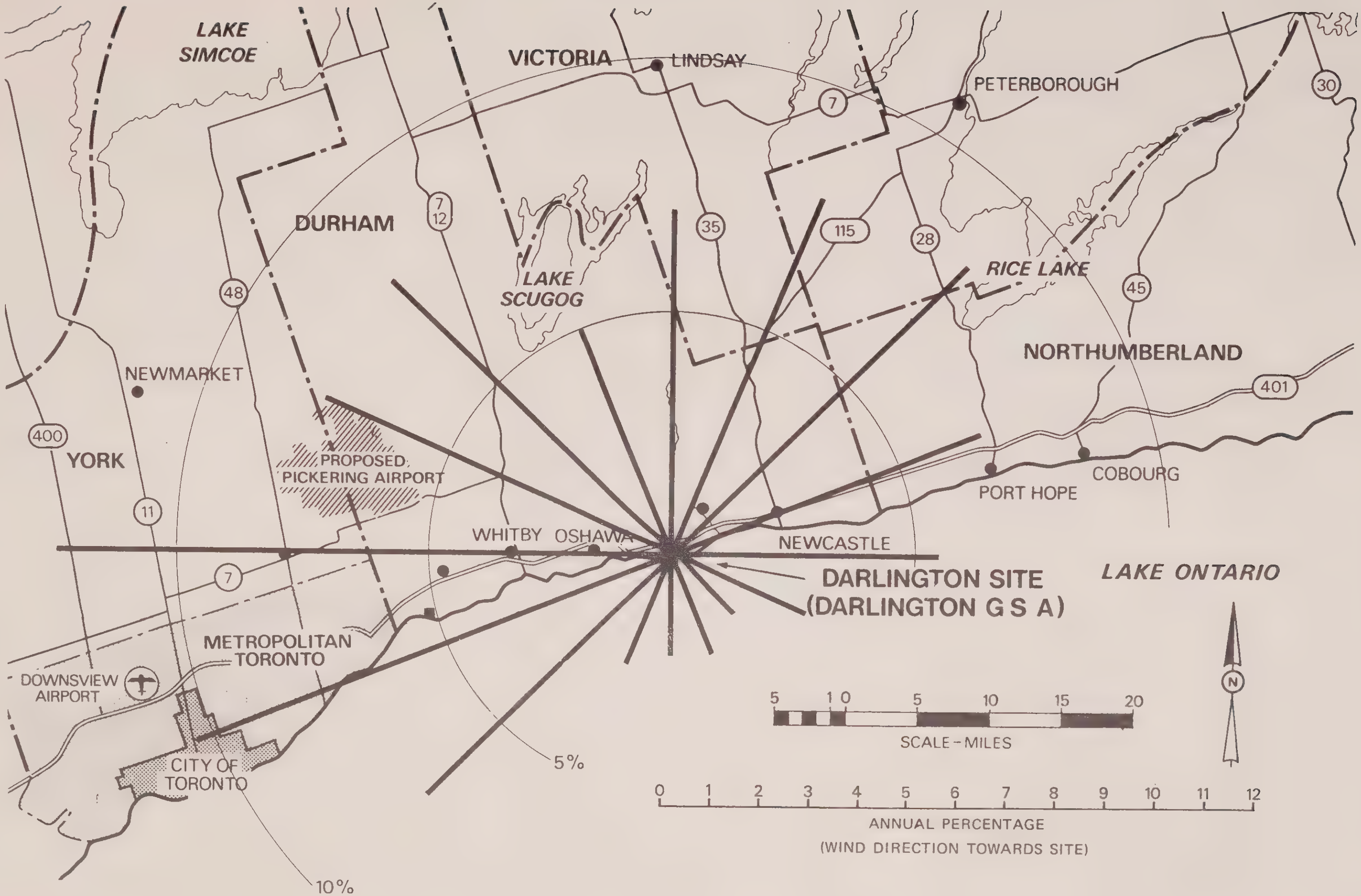


FIGURE 6–1 ANNUAL WIND DISTRIBUTION–FREQUENCY PERCENTAGE

TABLE 6.2

WIND DIRECTION - ANNUAL FREQUENCIES (PERCENT)

Location	Sampling Period	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
Wesleyville Site	1970-74	7	8	8	7	5	3	2	2	2	3	7	11	13	8	8	5	1
Toronto International Airport	1955-66	12	3	3	3	4	2	4	4	6	5	9	7	11	7	7	8	5
Trenton Airport	1955-66	5	5	6	5	4	2	2	2	3	7	13	9	6	8	8	6	10

TABLE 6.3

WIND SPEEDS - ANNUAL AVERAGE WIND VELOCITY (MPH)

Location	Sampling Period	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Wesleyville Site	1970-74	8.4	8.5	9.6	11.1	12.1	11.0	8.9	9.3	9.2	10.1	12.5	12.9	10.9	10.3	10.1	9.2
Toronto International Airport	1955-66	8.9	8.4	7.5	9.3	10.1	10.1	8.0	8.5	8.0	10.1	11.5	12.7	11.8	12.5	10.6	10.8
Trenton Airport	1955-66	9.2	8.1	8.9	9.6	8.9	8.9	9.2	10.9	9.5	11.2	12.0	13.3	12.7	13.7	12.0	10.9

6.1.2.3 Atmospheric Stability

Atmospheric stability defines the potential of the atmosphere to disperse airborne emissions. The diffusion and dispersion characteristics of any gaseous releases from Darlington GS A are determined by the stability of the atmosphere. Pasquill stability categories and vertical temperature gradients are the two most common methods of defining atmospheric stability conditions.

Pasquill proposed six stability categories, A (very unstable) through F (stable), which are used to aid in the prediction of dispersion patterns (16). The Pasquill categories are determined by wind speed, incoming solar radiation and cloud cover. Toronto International Airport and the Canadian Forces Base at Trenton regularly record these data, which are summarized in terms of Pasquill Stability Class System in Table 6.4 and 6.5 (15). Trenton is assumed to experience conditions which are most representative of the Darlington site.

However, the use of Pasquill categories in determining the frequency of various stability conditions is limited, since the method only records nighttime inversions. At the site, daytime inversions are expected during lake breeze occurrences when stable layers will flow off the cold lake, particularly in the spring and summer. Pasquill data must be supplemented by additional information in order to predict the frequency of inversion conditions on site during the daytime.

Vertical temperature gradients will provide this information but only limited data are available for the site at present. From data gathered during a six day on-site study (17), the vertical temperature distributions during June 1971 indicated inversions below 200 metres on each survey day. Onshore wind flows were dominant during this period. Extensive meteorological studies have been carried out at the Wesleyville site (15 miles east) and will provide data applicable to the Darlington site (140).

TABLE 6.4

PERCENT FREQUENCY DISTRIBUTION OF PASQUILL STABILITY CATEGORIES
TORONTO INTERNATIONAL AIRPORT

Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
A	3.1	3.3	3.5	4.9	5.9	7.9	9.1	9.0	7.5	5.3	3.5	3.1	6.0
B	5.7	6.1	9.2	11.1	11.0	14.5	14.5	15.5	13.6	9.9	7.0	6.6	11.0
C	12.5	12.4	15.5	16.9	17.9	18.0	17.7	16.8	16.3	13.3	11.7	11.2	16.0
D	65.5	61.2	53.4	47.3	42.2	32.1	27.9	29.4	33.7	42.9	61.1	64.3	48.0
E	6.8	7.3	8.3	8.0	8.3	8.8	9.3	8.5	9.6	9.2	6.6	6.0	9.0
F	6.4	9.7	10.2	11.8	14.7	18.7	21.4	20.8	19.3	19.3	10.1	8.7	10.0

TABLE 6.5

PERCENT FREQUENCY DISTRIBUTION OF PASQUILL STABILITY CATEGORIES
TRENTON

Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
A	3.2	3.2	3.0	3.3	3.2	4.1	4.5	5.6	5.0	3.6	3.1	3.3	4.0
B	6.5	5.9	8.5	8.7	8.4	9.7	9.7	10.9	10.9	8.1	6.4	6.2	8.0
C	11.7	12.1	15.8	17.2	16.3	17.7	16.8	16.3	16.6	14.1	11.5	10.5	15.0
D	64.6	63.5	56.6	54.4	53.4	46.6	44.6	42.5	42.8	50.4	62.9	64.2	54.0
E	5.3	5.5	6.8	6.4	6.9	7.5	9.3	8.0	8.0	8.6	5.7	5.7	7.0
F	8.6	9.9	9.3	10.0	11.6	14.5	15.1	16.6	16.7	15.2	10.4	10.1	12.0

6.1.2.4 Building Design Data

The climatology design parameters, as summarized in the Canadian Building Code, for the Bowmanville area, apply to the site (18). They are as follows:

Criteria		Data
Design Temperatures:	January 2-1/2%	-3°F
	January 1%	-6°F
	July 2-1/2% DB	86°F
	WB	75°F
Degree Days Below 65°F		7600
Rainfall	15 minute	1.1 inches
	24 hour	3.0 inches
Total Annual Precipitation		32 inches
Ground Snow Load		44 psf
Hourly Wind Pressures 10%		9.6 psf
Hourly Wind Pressures 3.3%		11.5 psf
Hourly Wind Pressures 1.0%		13.7 psf

6.2 WATER

6.2.1 Quality

6.2.1.1 Radiological

At the Pickering site, water quality has been monitored by Ontario Hydro and the Radiation Protection Services, Ontario Department of Health. In general, data suggest that the operation of the Pickering station, including heavy water upgrading plant, has had some effect on the levels of radioactivity in water. Increased tritium levels have been detected in local water supplies, but these increases are only marginally above general lake water concentrations. The resulting dose is completely negligible; the alpha and beta activities of dissolved and undissolved solids has generally been below the lower detection limits of the monitoring equipment (approximately 1 pCi/l) with the exception of the beta activity in dissolved solids which averages approximately 6 pCi/l.

Although monitoring has not been carried out at the Darlington site, it is expected that the Pickering results are representative of the activities which would be found in the lake water at this site. Ontario Hydro's planned radiological monitoring program should confirm this.

6.2.1.2 Non-Radiological

Preliminary water analysis (Table 6.6) has been carried out by Ontario Hydro at the site as part of the initial biological investigation (19). The results of the water quality surveys by the Canada Centre for Inland Waters (20) from 1966 to 1969 are summarized in Table 6.7 for several sampling points near the proposed site.

Lake surveys have also been summarized in several papers (21, 22, 23). It was found that the total salt content and the specific conductance were increasing by 4% per decade (21). Average lake-wide concentrations of trace elements (22) surveyed in 1969 are shown in Table 6.8. The highest concentrations of iron, copper, zinc and nickel occurred in the western region near the Hamilton-Toronto area. The high levels of strontium are likely caused by geochemical processes rather than human activities.

Nutrient data were collected over a period of a year in 1969 and 1970 (23). The seasonal distribution of mean bottom concentrations of ammonia, nitrate and nitrite, soluble phosphate and total phosphate remained relatively constant at 20 to 30 μg/l, 200 to 250 μg/l, 20 to 40 μg/l and 60 to 80 μg/l, respectively. The seasonal distribution of mean surface concentrations were similar except for nitrate, nitrite and soluble phosphate which decrease substantially during the summer months. This suggests the use of these compounds as nutrients for aquatic plant growth.

Secchi disc readings obtained during biological investigations offshore varied from 1 foot to 12 feet. High readings were recorded in the spring and fall, with the lowest readings found during the summer at inshore locations where the existing shoreline erosion caused turbid water (24).

Lake-wide temperature and dissolved oxygen measurements made in the summer of 1966 determined a lower limit in the main basin of 70% saturation. In the summer, the surface waters had high saturation values (100 to 155%). The mean saturation in the hypolimnion was 100% in June and 94% in September (21). Variations in the dissolved oxygen saturation values similar to the lake-wide pattern reported were found during the site biological investigation in 1972 (24). The rapid warming of the water and photosynthetic activity in early summer resulted in saturation values as high as 160% in late May (24).

The International Joint Commission report on pollution in the Great Lakes provides information on the sources and levels of pollution in Lake Ontario. There are no major municipal or industrial wastes discharged directly to Lake Ontario within five miles of the site (25).

TABLE 6.6

WATER QUALITY ANALYSIS, 1973 (19)

		Range
pH at 25°C		6.9-7.9
Turbidity	FTU	0.3-32
Secchi Disc	Ft	1.0-12 (Ref. 24)
Dissolved Solids	mg/l	184-211
Total Phosphate (PO_4)	mg/l	0.01-0.3
Nitrate (NO_3)	mg/l	0.13-1.6
Nitrite (NO_2)	mg/l	0.01-0.03
Iron (Fe)	mg/l	0.1-0.6
Manganese (Mn)	mg/l	0.1*

* single result

TABLE 6.7

WATER QUALITY ANALYSIS, 1966 - 1969 (20)

		Range
pH at 25°C		8.0-8.8
Specific Conductivity	micromhos	285-352
Turbidity	FTU	0.1-4.0
Dissolved Oxygen	mg/l	7.6-14.4
Total Phosphate	mg/l	0.005-0.130
Kjeldahl Nitrogen (N)	mg/l	0.3-1.6
Ammonia (N)	mg/l	0.005-0.220
Nitrate and Nitrite (N)	mg/l	0.002-0.590
Total Alkalinity ($CaCO_3$)	mg/l	60-97.5
Hardness ($CaCO_3$)	mg/l	126-138
Phenol	mg/l	0.000-0.010
Chloride	mg/l	22.5-29
BOD (C)	mg/l	0.3-1.6

TABLE 6.8

AVERAGE VALUES OF TRACE ELEMENTS, 1969 (22)
LAKE ONTARIO

Element		ug/l
Cadmium	(Cd)	0.09
Chromium	(Cr)	0.74
Cobalt	(Co)	0.11
Copper	(Cu)	6.40
Iron	(Fe)	5.12
Lead	(Pb)	0.83
Manganese	(Mn)	0.47
Molybdenum	(Mo)	1.08
Nickel	(Ni)	2.32
Strontium	(Sr)	184.70
Vanadium	(V)	0.03
Zinc	(Zn)	7.84

An investigation of the "thermal bar" phenomenon has been carried out offshore from the Darlington site (26). The thermal bar acts as a barrier separating the warmer, more productive inshore waters from the mid-lake waters and also inhibits the diffusion of chemicals and bacteria from the inshore to the offshore area. The thermal bar in Lake Ontario lasts for a period varying from four to eight weeks.

6.2.2 Currents

6.2.2.1 Ambient Lake Conditions

Lake currents were recorded by Ontario Hydro from June to November 1971, and April to November 1972 using an in-situ current and temperature recorder which was located on the site centreline 4,000 feet offshore at about 25-foot depth in about 46 feet of water. Frequency of occurrence by direction and speed class is given for 1971 in Tables 6.9 and 6.10 and for 1972 in Tables 6.11 and 6.12. In addition, these frequencies of occurrence for the two years are compared in Figures 6-2 and 6-3.

The current patterns were essentially the same in 1971 and 1972. Lake currents were to the east and west quadrants, or alongshore, almost 80% of the time with a predominance to the west quadrant. The direction of the net transport was toward the west and south-west. Current direction and speed by quadrants for the two years are summarized below:

CURRENT DIRECTION (TO)	1971 Jun 3-Nov 8	1972 Apr 14-Nov 30
E (% Time)	31	30
W (% Time)	48	48
N (% Time)	5	6
S (% Time)	16	14
Calm (% Time)	-	2
Total E&W Quad. (% Time)	79	78
Net	233°	252°
CURRENT SPEED (ft/sec)		
Mean	0.32	0.33
Max.	1.00	0.96
Net Magnitude	0.09	0.07

TABLE 6.9

LAKE CURRENTS
FREQUENCY OF OCCURRENCE AND TRANSPORT BY DIRECTION

1971
JUNE 3 - NOVEMBER 8

CURRENT	OCCURRENCE		TRANSPORT		SPEED IN FT/SEC	
DIRECTION (TO)	HOURS	PERCENT	FT. x 10^3	PERCENT	AVERAGE	MAXIMUM
N	26	0.69	10.98	0.25	0.12	0.30
NNE	37	0.98	20.70	0.47	0.16	0.40
NE	88	2.33	65.34	1.49	0.21	0.35
ENE	145	3.84	122.22	2.79	0.23	0.60
E	489	12.95	540.18	12.32	0.31	1.00
ESE	391	10.35	534.60	12.19	0.38	0.95
SE	165	4.37	212.94	4.86	0.36	0.70
SSE	165	4.37	183.78	4.19	0.31	0.70
S	165	4.37	178.74	4.08	0.30	0.75
SSW	124	3.28	122.58	2.80	0.27	0.70
SW	184	4.87	199.62	4.55	0.30	0.75
WSW	478	12.66	600.48	13.70	0.35	0.95
W	985	26.08	1331.82	30.38	0.38	0.90
WNW	208	5.51	183.60	4.19	0.25	0.60
NW	93	2.46	59.58	1.36	0.18	0.40
NNW	32	0.85	16.74	0.38	0.15	0.25
CALM	2	0.05				
TOTAL	3777	100.00	4384.44	100.00		

Net current speed is 0.09 ft/sec at 233 degrees. Mean current speed is 0.32 ft/sec.

Persistence factor $\frac{(Vnet)}{(Vmean)}$ is 0.29.

TABLE 6.10

LAKE CURRENTS
PERCENTAGE FREQUENCY BY DIRECTION AND SPEED CLASS

1971
JUNE 3 - NOVEMBER 8

CURRENT DIRECTION (TO)	CURRENT SPEED IN FT./SEC. 0.00 - .19	.20 - .39	.40 - .59	.60 - .79	.80 - .99	1.00 - 1.19	≥1.20	TOTAL
N	0.58	0.11	0.00	0.00	0.00	0.00	0.00	0.69
NNE	0.66	0.29	0.03	0.00	0.00	0.00	0.00	0.98
NE	0.82	1.51	0.00	0.00	0.00	0.00	0.00	2.33
E	1.09	2.57	0.16	0.03	0.00	0.00	0.00	3.84
E	1.64	8.47	2.09	0.56	0.16	0.03	0.00	12.95
ESE	1.01	4.85	2.62	1.62	0.26	0.00	0.00	10.35
SE	0.98	1.32	1.35	0.71	0.00	0.00	0.00	4.37
SSE	1.03	1.91	1.16	0.26	0.00	0.00	0.00	4.37
S	1.09	1.96	1.03	0.29	0.00	0.00	0.00	4.37
SSW	1.03	1.48	0.58	0.19	0.00	0.00	0.00	3.28
SW	1.03	2.44	1.19	0.21	0.00	0.00	0.00	4.87
WSW	1.54	6.38	3.07	1.40	0.26	0.00	0.00	12.66
W	2.83	11.38	8.50	3.02	0.34	0.00	0.00	26.08
WNW	1.32	3.47	0.66	0.05	0.00	0.00	0.00	5.51
NW	1.27	1.11	0.08	0.00	0.00	0.00	0.00	2.46
NNW	0.50	0.34	0.00	0.00	0.00	0.00	0.00	0.85
CALM	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05
TOTAL	18.48	49.59	22.53	8.34	1.03	0.03	0.00	100.00

TABLE 6.11

LAKE CURRENTS
FREQUENCY OF OCCURRENCE AND TRANSPORT BY DIRECTION

1972
APRIL 14 - NOVEMBER 30

CURRENT DIRECTION (TO)	OCCURRENCE		TRANSPORT		SPEED IN FT/SEC	
	HOURS	PERCENT	FT. x 10^3	PERCENT	AVERAGE	MAXIMUM
N	19	0.35	13.54	0.21	0.20	0.70
NNE	66	1.23	68.47	1.08	0.29	0.58
NE	183	3.41	197.32	3.11	0.30	0.68
ENE	309	5.76	278.50	4.39	0.25	0.80
E	899	16.75	1237.79	19.49	0.38	0.92
ESE	237	4.42	250.85	3.95	0.29	0.72
SE	166	3.09	149.54	2.35	0.25	0.70
SSE	196	3.65	209.45	3.30	0.30	0.70
S	292	5.44	301.68	4.75	0.29	0.68
SSW	107	1.99	96.05	1.51	0.25	0.54
SW	178	3.32	167.83	2.64	0.26	0.68
WSW	434	8.09	471.74	7.43	0.30	0.80
W	1568	29.22	2210.54	34.81	0.39	0.96
WNW	444	8.27	540.43	8.51	0.34	0.95
NW	132	2.46	118.12	1.86	0.25	0.74
NNW	51	.95	38.70	0.61	0.21	0.50
CALM	86	1.60	0.00	0.00	0.00	-
TOTAL	5367	100.00	6350.65	100.00		

Net Transport: speed - 0.07 ft/sec., direction 252 degrees.
Mean current speed - 0.33 ft./sec.
Maximum current speed - 0.96 ft./sec.

Persistence factor ($\frac{V_{net}}{V_{mean}}$) = 0.22

TABLE 6.12

LAKE CURRENTS
PERCENTAGE FREQUENCY BY DIRECTION AND SPEED CLASS

1972
APRIL 14 - NOVEMBER 30

CURRENT DIRECTION (TO)	CURRENT SPEED IN FT./SEC. 0.00 -0.19	0.20 -0.39	0.40 -0.59	0.60 -0.79	0.80 -0.99	1.00	TOTAL
N	0.19	0.15	0.00	0.02	0.00	0.00	0.35
NNE	0.45	0.47	0.32	0.00	0.00	0.00	1.23
NE	0.78	1.63	0.89	0.11	0.00	0.00	3.41
ENE	2.13	3.15	0.28	0.19	0.02	0.00	5.76
E	3.75	6.04	2.79	3.28	0.89	0.00	16.75
ESE	1.64	1.34	1.16	0.28	0.00	0.00	4.42
SE	1.45	0.76	0.71	0.17	0.00	0.00	3.09
SSE	1.04	1.64	0.82	0.15	0.00	0.00	3.65
S	1.53	2.59	1.19	0.13	0.00	0.00	5.44
SSW	0.75	0.88	0.37	0.00	0.00	0.00	1.99
SW	1.21	1.29	0.75	0.07	0.00	0.00	3.32
WSW	1.94	4.29	1.49	0.34	0.04	0.00	8.09
W	3.35	12.71	8.27	4.40	0.48	0.00	29.22
WNW	1.49	3.82	2.27	0.45	0.24	0.00	8.27
NW	1.10	0.91	0.41	0.04	0.00	0.00	2.46
NNW	0.47	0.35	0.13	0.00	0.00	0.00	0.95
CALM	1.60	0.00	0.00	0.00	0.00	0.00	1.60
TOTAL	24.86	42.00	21.86	9.61	1.68	0.00	100.00

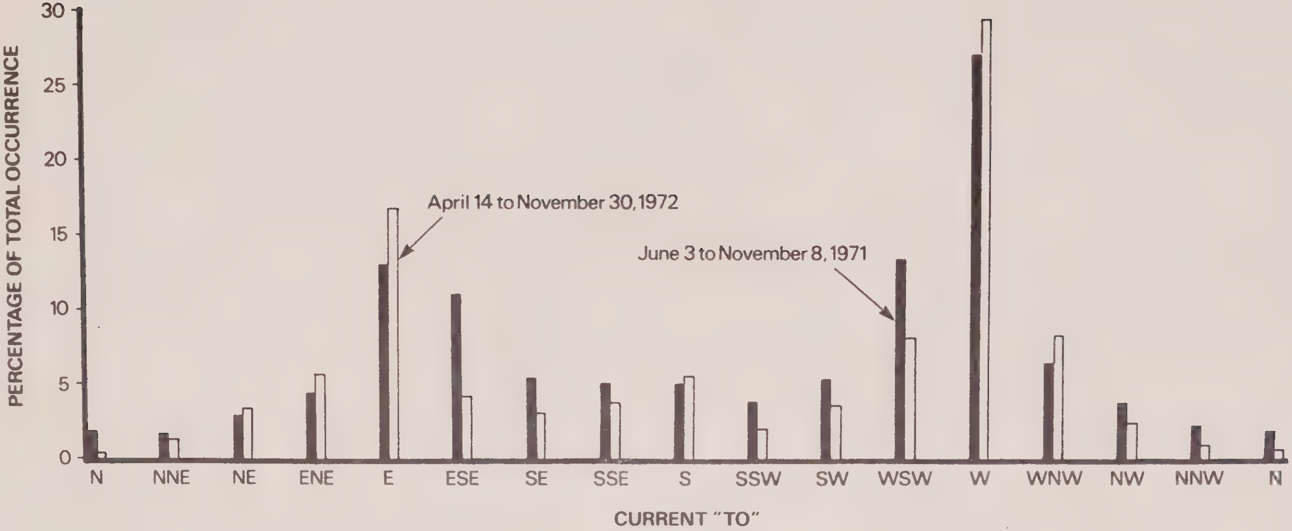


FIGURE 6–2 FREQUENCY OF LAKE CURRENTS AT DARLINGTON SITE 1971–1972

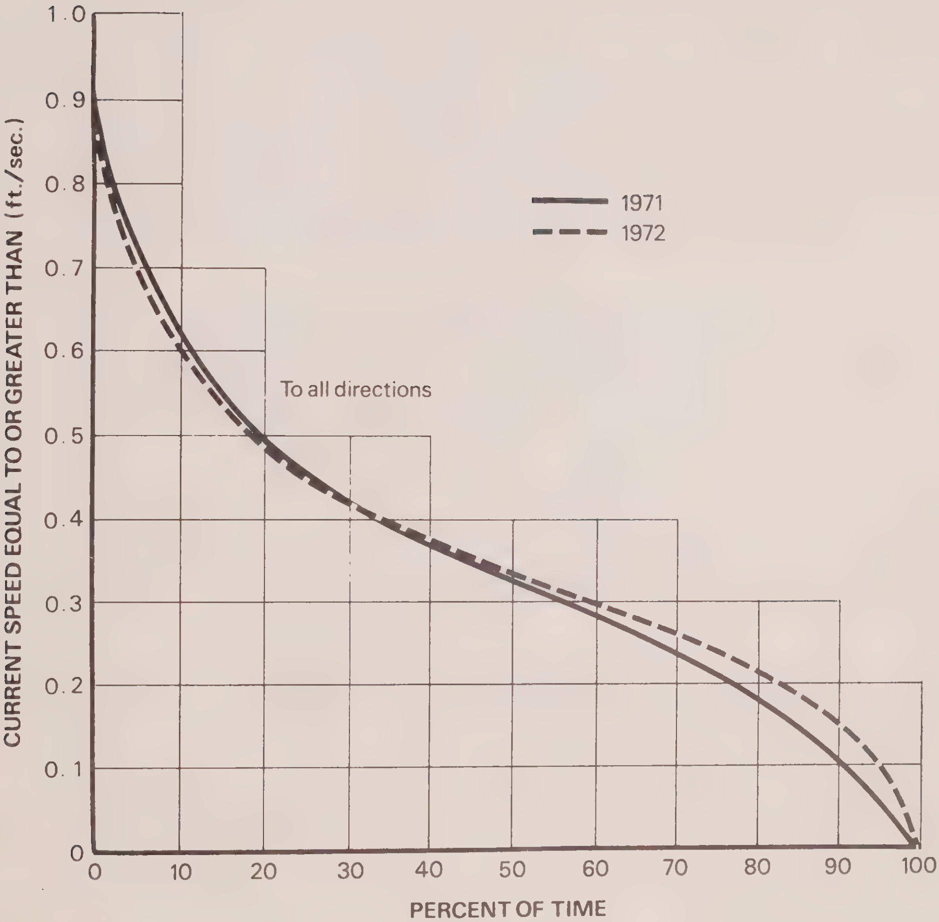


FIGURE 6–3 DARLINGTON SITE DURATION CURVES OF CURRENT SPEED 1971 AND 1972

6.2.3 Temperatures

6.2.3.1 Ambient Lake Conditions

Water temperatures were recorded by Ontario Hydro offshore from the Darlington site at depths of 5, 26, and 70 feet from May to November of 1971, and at depths of 5, 25, 40, and 70 feet from May to November of 1972. These temperatures are summarized by months in Tables 6.13 and 6.14 in terms of monthly mean, maximum and minimum daily mean, and hourly maximum and minimum. The temperatures differed appreciably from one year to the next. At 5-foot depth about 100 feet offshore the temperature records were incomplete, however, the warmest temperatures that were recorded occurred in August of both years, the maximum daily being 71°F and the maximum hourly, 77°F. At 25-foot or 26-foot depth, 4,000 feet offshore, the highest monthly mean temperatures were 63°F in September 1971, and 58°F in August and September 1972, the maximum daily for the two years was 69°F and the maximum hourly, 71°F. At 70-foot depth, 7,000 feet offshore, the highest monthly mean temperatures were 57°F in September 1971, and 51°F in August and September 1972, the maximum daily for the two years was 68°F, and the maximum hourly, 70°F.

Large temperature variations occurred from day-to-day, and within the day on several occasions during both 1971 and 1972. Consecutive daily mean temperatures varied by as much as 18F° at 5-foot depth, 14F° at 26-foot depth and 13F° at 70-foot depth. Hourly temperatures varied within the day by as much as 22F° at 5-foot depth, 23F° at 26-foot depth and 16F° at 70-foot depth. Figure 6-4 shows the continuous record of daily mean temperatures observed in 1972.

Vertical temperature profiles obtained in 1971 and 1972 at various distances offshore up to 9,000 feet indicated surface warming commencing in June, large temperature gradients in July and August and a return to isothermal conditions in October.

Offshore water temperatures have been measured during water quality surveys by the Canada Centre for Inland Waters (CCIW) (20) from 1966 to 1969, and during aquatic biological investigations carried out by Ontario Hydro during 1972 (24). In 1969, the CCIW found that the vertical temperature profile increased from an isothermal 4°C in April following the pattern described above to a September maximum of 21°C returning to an isothermal 3°C in December (20). The vertical temperature data for a bottom fauna sampling station 2000 feet from shore are shown in Table 6.15 for the period May to October, 1972 (24).

TABLE 6.13

LAKE ONTARIO WATER TEMPERATURE ^{o}F, 1971

	Distance from Shore (feet)	Depth (feet)	May	Jun	Jul	Aug	Sept	Oct	Nov
Monthly Mean	100	5		57	53	58		53*	
	4,000	26		51*	47	55	63	54	
	7,000	70		41	41	47	57	50	
Max. Daily Mean	100	5	49*	67	66	70	68*	57	
	4,000	26		64	62	66	69	62	57*
	7,000	70	41*	44	46	59	68	59	54*
Min. Daily Mean	100	5		46	44	47	64	47	
	4,000	26		43	40	40	52	42	
	7,000	70		40	39	40	51	40	
Max. Hourly	100	5	50*	72	69	73	77*	59	
	4,000	26		66	65	68	70	63	58*
Min. Hourly	100	5		44	42	45	63*	46	
	4,000	26		40	38	39	44	41	

* Partial month

TABLE 6.14

LAKE ONTARIO WATER TEMPERATURE °F, 1972

	Distance from Shore (feet)	Depth (feet)	May	Jun	Jul	Aug	Sept	Oct	Nov
Monthly Mean	100	5		47*		64*	60	48	
	4,000	25	43*	46*	47	58	58	47*	46
	4,000	40	43	43	46*	55	54	48	46
	7,000	70			44	51	51	46	
Max. Daily Mean	100	5		55*		71*	68	61	
	4,000	25	46*	53*	54	67	62	60*	50
	4,000	40	47	54	52*	64	61	61	49
	7,000	70			46	59	60	59	48*
Min. Daily Mean	100	5		41*		53*	53	40	
	4,000	25	40*	41*	43	45	47	40*	41
	4,000	40	40	39	42*	43	44	41	42
	7,000	70			42	42	43	40	
Max. Hourly	100	5		63*		74*	72	61	
	4,000	25	49*	54*	59	71	65	61*	50
	4,000	40	48	54	53*	66	62	63	50
	7,000	70			47	64	61	59	48*
Min. Hourly	100	5		37*		47*	47	40	
	4,000	25	39*	39*	41	42	42	40*	40
	4,000	40	39	38	42*	43	43	41	41
	7,000	70			41	41	43	40	

* Partial month

TABLE 6.15

VERTICAL TEMPERATURE DATA
BIOLOGICAL INVESTIGATIONS 1972

	Temp °C					
Depth feet	May 25	Jun 29	Jul 21	Aug 18	Sept 20	Nov 2
0	11.5	12.0	18.5	16.7	11.2	8.1
5	10.2	10.2	17.0	16.6	10.7	8.1
10	9.5	9.8	12.5	16.5	10.7	8.1
15	8.3	9.3	10.5	16.4	10.4	8.1
20	8.0	8.8	10.0	16.4	10.3	8.1
25	7.8	8.8	10.0	16.4		

Data recorded at bottom fauna sampling station 2000 feet from shore (24)

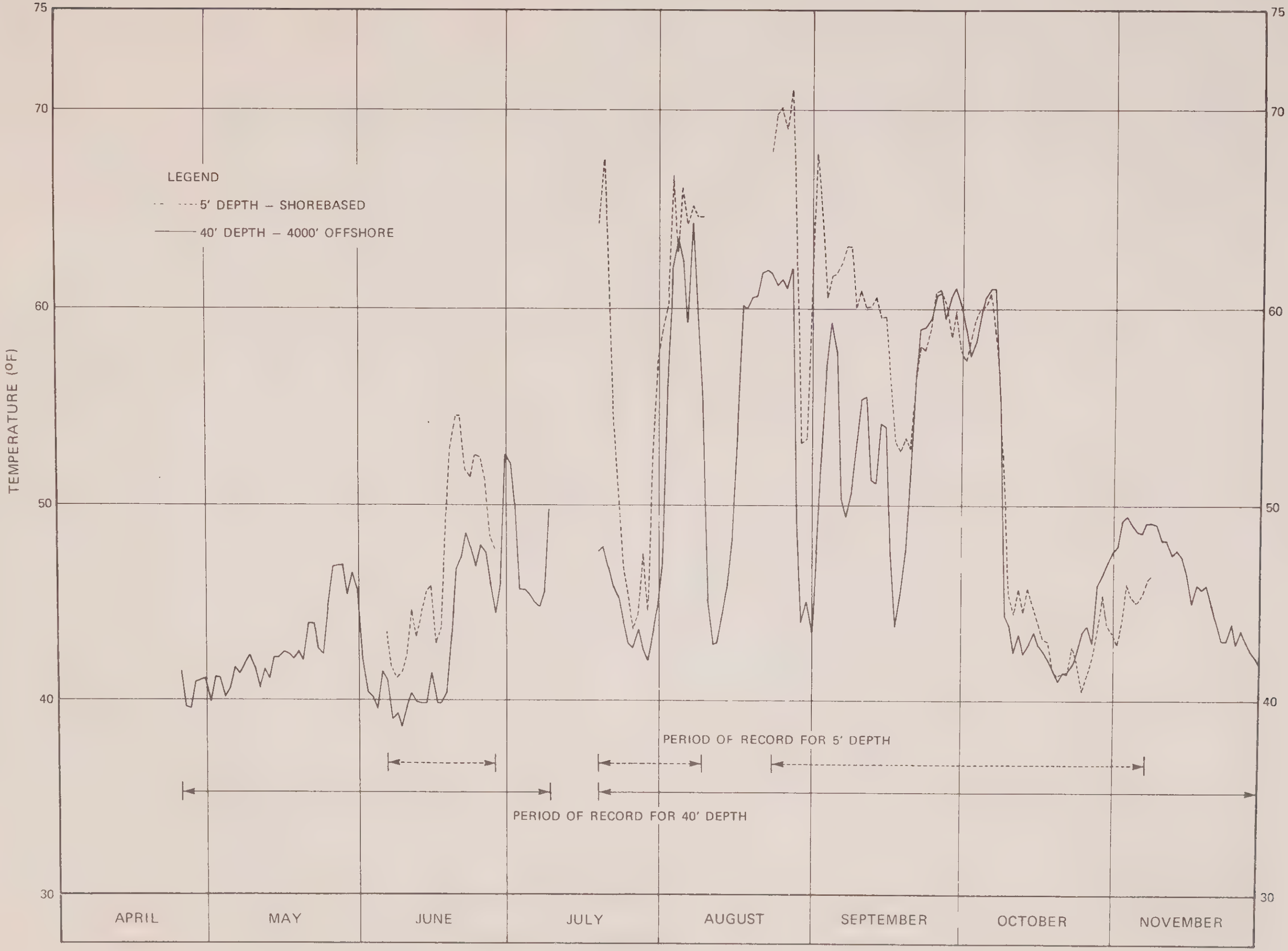


FIGURE 6–4 DAILY MEAN WATER TEMPERATURE AT THE DARLINGTON SITE – 1972

6.2.4 Ice

Limited observations of ice conditions in Lake Ontario in the vicinity of the site have been made beginning in 1971. The observations consisted of general reconnaissance from an aircraft and of ground observations to determine ice conditions along the shore. No extensive ice cover has been observed, only shore and slush ice which has developed into ridges extending as much as 100 feet from shore.

6.2.5 Aquatic Life

6.2.5.1 Fish

Improving water quality and the recent trends to reintroduce fish species has strongly influenced the character of Lake Ontario fisheries. Two recent Ministry of Natural Resources surveys (27, 28) identify local fishing and spawning sites. Several creeks within seven miles of the Bowmanville site are open to migrating rainbow trout. These include Oshawa and Harmony Creeks (five miles west), Darlington and Soper Creeks (three miles east), Wilmot Creek (six miles east) and Graham Creek (seven miles east). Coho salmon have been caught in two areas; at the mouth of Wilmot Creek and off Bond Head. The area off Bond Head is also a long established spawning area for smelt and was once heavily populated by whitefish and white bass. Rainbow trout are also suspected to spawn here. The area off Port Granby (thirteen miles east of the Darlington site) is a spawning area for jumbo smelt, whitefish and rainbow trout. There is a secondary stream at Port Granby which has potential for migrating rainbow trout and is used by commercial bait fish operators. A broadly defined area, approximately fourteen miles southeast of the Darlington site (twelve miles offshore from the Port Granby to Lakeport region), is frequented by commercial fishermen. The area is noted for jumbo smelt, lake trout and was formerly known as a major lake trout spawning area. Figure 6-5 illustrates the location of these areas.

In 1971 there were three individuals licensed to take bait fish from waters entering Lake Ontario within 10 miles of the Darlington site. These operators recorded a catch for the year of approximately 600 dozen shiner, chub, sucker, dace and darter minnows for sale to the angling public. There were 21 individual licensees along the entire Lindsay District shoreline who held 24 licences for 117,000 yards of gillnet, 15 trap nets and 450 baited hooks (28).

The commercial fish harvest based on landings and values by species during 1971, 1972 and 1973 is summarized in the following table (42):

Species	1971		1972		1973	
	lbs.	$	lbs.	$	lbs.	$
Carp	29	3	-	-	93	23
Eels	190	0	-	-	100	15
Northern Pike	33	10	42	13	-	-
Yellow Perch	57	10	-	-	-	-
Sucker (Mullet)	31	0	-	-	-	-
Smelt	32,952	7,380	30,266	6,898	12,990	4,224
White Bass	15	3	-	-	-	-
Lake Whitefish	-	-	46	27	21	0
Animal Food * (Unclassified)	-	-	13	0	28	0
Total Landings (lbs)	33,307		30,367		13,232	
Total Landed Value ($)		$7,406		$6,938		$4,262

* Animal Food includes mixed scrap fish

In 1972 an Ontario Hydro study (24) indicated that the fish populations off the site were low. Trap nets, set during the period of May to October at three locations (Figure 6-6), found fourteen fish species. The species and corresponding number of each caught during the study is given as follows:

Alewife	-	*Alosa pseudoharengus*	489
Sucker	-	*Catostomus commersonni*	255
Brown Bullhead	-	*Ictalurus nebulosus*	59
White Perch	-	*Morone americana*	11
Yellow Perch	-	*Perca flavescens*	10
American Eel	-	*Anguilla rostrata*	9
Smelt	-	*Osmerus mordax*	6
Carp	-	*Cyprinus carpio*	4
Sunfish	-	*Lepomis macrochirus*	3
Chub	-	*Couesius plumbeus*	3
Pumpkinseed	-	*Lepomis gibbosus*	2
Lamprey	-	*Petromyzon marinus*	1
Silver bass	-	*Morone chrysops*	1
Rock Bass	-	*Ambloplites rupestris*	1

Over half of the alewives were caught in May.

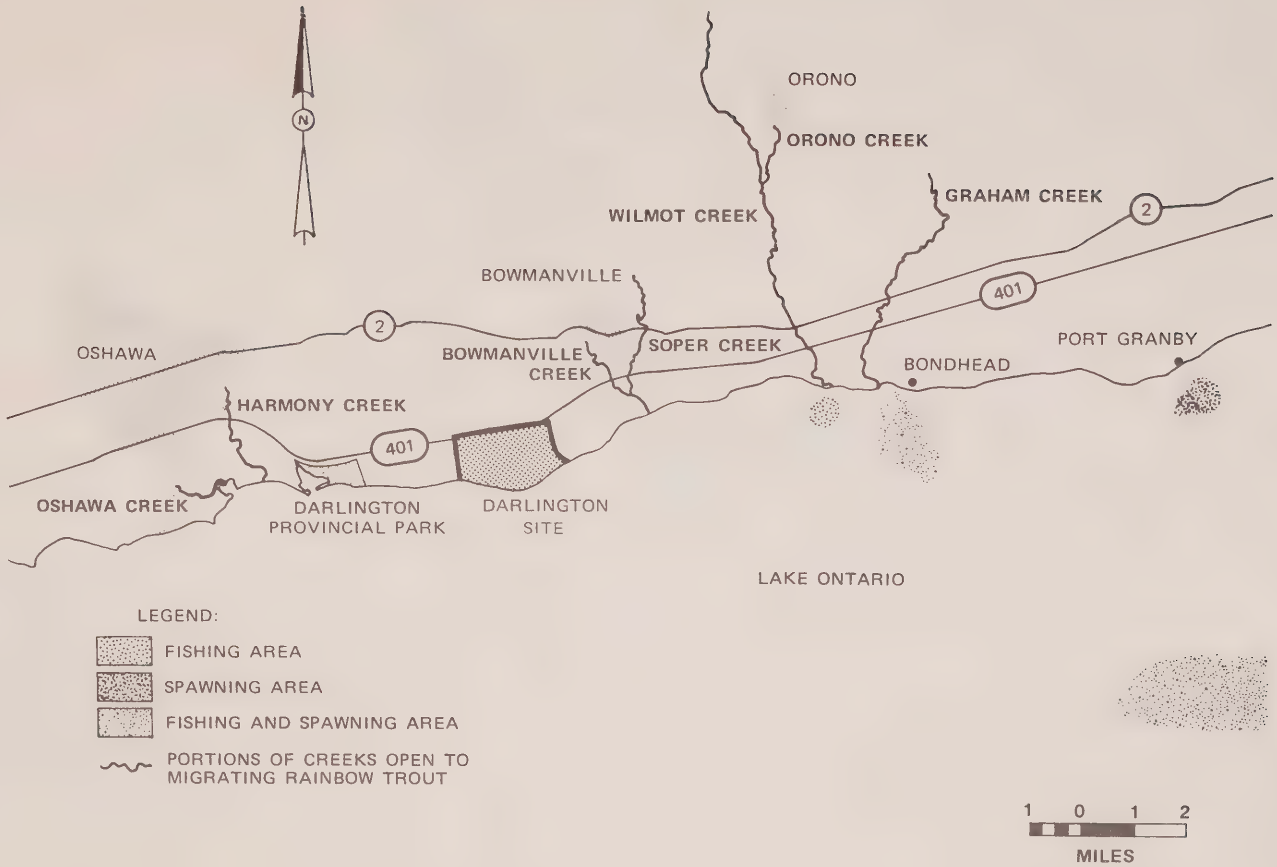


FIGURE 6–5 FISHING AND SPAWNING AREAS

FIGURE 6–6 AQUATIC BIOLOGY STUDY SITES DARLINGTON – 1972

6.2.5.2 Bottom Fauna

An area extending from the western end of the Scarborough Bluffs to east of the Darlington site was surveyed for bottom fauna in 1966-1967 (25). The results are indicative of oligotrophic conditions. The average community based on numbers per unit area consisted of:

amphipods	39.0%
lumbiculids	24.0%
midges	12.0%
clams	12.0%
tubificids	12.8%

An Ontario Hydro study in 1972 (24) made monthly measurements of bottom fauna at six locations in two depths (Figure 6-6). Apart from large numbers of _Hydra_ (Coelenterata), found in September and October, the populations were dominated by _Asellus_ (Isopoda) and _Gammarus_ (Amphipoda). Populations were similar to other sites along the northern shoreline of Lake Ontario such as Lakeview (51), Pickering (105, 106) and Wesleyville generating stations.

6.2.5.3 Phytoplankton

The central part of the lake is characterized by low densities of algae and fairly homogeneous lateral distribution of plankton, whereas the inshore areas show a more irregular but higher distribution pattern. Diatoms, cryptomonads and green algae, in that order, are the most important constituents of the lake phytoplankton, while chrysomonades and dinoflagellates do not play the role they could have been expected to, from the temperature and nutrient conditions of the lake. The annual average composition of the phytoplankton for the general area around the Darlington site was found to be (29):

Cyanophyta	10%	(blue-green)
Chlorophyta	16%	(green)
Chrysomonadinae	15%	(yellow-green)
Diatomeae	33%	(diatoms)
Cryptomonadinae	20%	(yellow-brown flagellates)
Dinophycinae	6%	(armoured flagellates)

In the winter and spring, diatoms are 80% of the plankton volume. The plankton in the summer maximum and the fall show more diversity, with green algae as the biggest single group, followed in importance by blue-greens and cryptomonads. A pronounced spring maximum appears in the inshore region. The summer maximum develops earlier but more irregularly in the offshore region. Stations are defined as inshore if they are less than 25 metres deep (29).

The persistence of certain diatom species within the inshore regions during all seasons of the year may be indicative of eutrophic conditions in the near shore waters of Lake Ontario (25). In the main

body of the lake, however, phytoplankton concentrations indicate mesotrophic to oligotrophic conditions.

Ontario Hydro studies in 1972 (24) showed that Asterionella, Fragilaria, Nitzschia and Tabellaria were common diatoms, Ulothrix the only common green alga and Oscillatoria a common blue-green alga in July. Percentage composition by month was found to be:

Month	Diatoms	Greens	Blue-green
Apr	43	57	0
May	41	50	9
Jul	48	7	45
Aug	75	23	2
Sept	76	24	0

6.2.5.4 Zooplankton

There is very little published information on the zooplankton population in the vicinity of the Darlington site. The Ministry of the Environment sampled in Lake Ontario regularly between May and September 1967. On the average, the eastern part of the lake was richer in planktonic crustacea than the western and central parts (25).

An Ontario Hydro study in 1972 (24) indicated only low numbers at the surface and 10 foot depths except in August. Bosmina was the most common species, followed by Cyclops, Daphnia, Kellicottia, Keratella and Polyarthra.

6.2.5.5 Periphyton and Aquatic Macrophytes

Fairly dense growths of the filamentous alga, Cladophora, in the shallow water near the site have been observed (30). The rocky, shallow nature of the shoreline, a moderate nutrient content and good water turbulence contribute to the dense growth, whereas the high turbidity of the water in the vicinity of the site will tend to restrict the growth. The algae first appears in late May with rapid growth and spreading occurring during May, June and July. Heavy wave action causes fragmentation after this time and with onshore wind conditions, shoreline accumulations can result. The process of fragmentation and shoreline accumulation carries on into September and October.

6.2.5.6 Bacteriology

The bacteriological quality of the water in the vicinity of the Darlington site is good (25). The bacteriological quality of Lake Ontario is excellent in deep water but is somewhat degraded along the shoreline and in harbour areas. The coliform-polluted areas appear to

be limited to water well within two miles off the shoreline from the source. High bacterial densities show a close correlation with heavily polluted areas. The area in the vicinity of the site is not highly populated or industrialized. Oshawa and Bowmanville are the two nearest communities whose sewage treatment effluents are discharged into Harmony Creek (five miles west) and Soper Creek (three miles east). The spring thermal bar phenomenon (26) may increase the bacterial density in the nearshore area by prohibiting proper dispersion in the lake.

6.2.6 Surface and Ground Water

The surficial soil within the site area is fairly well drained and no large permanent drainage system has developed. However, there are several small, steep-walled gullies and a few small poorly drained swampy areas within the site. In the west half of the site where the proposed Darlington GS A is located, these gullies and poorly drained areas are found close to the shorecliff near the western site boundary.

The ground water level as indicated in the observation wells is about 5 to 20 feet below the ground surface. The trend of the ground water movement is from north to south, and approximately perpendicular to the shoreline with a relatively flat gradient. However, readings from piezometers located within the interglacial sands and silts immediately below the upper till layer show that a piezometric water level, generally 5 to 15 feet higher than the ground water level in the area, exists. Along the proposed cut slopes between the switchyard and the powerhouse yard areas, the piezometric water level is 10 to 15 feet higher, causing artesian or sub-artesian conditions in some places.

6.3 SITE AREA

6.3.1 Topography

The Darlington site is situated in an undulating to moderately rolling limestone till plain spotted with remnants of a lake plain deposit. Along the shore, steep to near vertical cliffs rise some 40 to over 100 feet above the mean lake water level of El. 245. This shorecliff is continually being eroded by wave action from the lake. Presently, the shoreline is receding at a rate of about three feet per annum. Inland, the terrain is irregular but generally rises towards the north. The mean ground surface elevation south of the CNR tracks is at about El. 300. North of the tracks, the ground is about 50 feet higher. A high ridge, starting from the shore just east of Raby Head, extends diagonally across the site in a northwesterly direction with levels ranging up to 50 feet above the surrounding ground.

On the west half of the site where Darlington GS A is to be located, the land is generally higher than the east half, ranging from El. 280 to El. 320 along the top of the shorecliff to El. 340 at the CNR tracks, and to a high of El. 420 near the north boundary of the site.

6.3.2 Geology

The land portion of the site area is covered by a thin layer of top soil and glacio-lacustrine silts and clays generally less than 10 feet thick. Underneath is a layer of dense to very dense, well-graded, sandy silty till of varying thickness, from 0 to about 80 feet, but generally between 20 and 50 feet. Below the till is a thick deposit (up to 70 feet) of complex interglacial materials consisting of dense, layered, uniform sands and silts and slightly plastic silts and clays. Underneath the interglacial materials and immediately over bedrock is a relatively thin, generally less than 10 feet, layer of very dense, silty till.

Bedrock is not exposed anywhere within the site. From information obtained during site investigations and from a quarry located at about 1,000 feet east of the site, it is found that bedrock belongs to the Black River-Trenton Limestone Group of Middle Ordovician period. The bedrock consists of dark brown, fresh, dense, thin-bedded, and flat-lying shaly limestone up to about 30 feet thick, conformably overlying a gray, fresh, dense, medium to massive bedded, fossiliferous limestone in excess of 135 feet thick. Generally the bedrock surface is flat from east to west, but slopes down gently towards the lake from El. 225 near the CNR track to El. 202 at the shoreline near Raby Head.

Offshore, both the glacio-lacustrine and the upper sandy till layers are absent. The lake bottom is covered with the interglacial sands and silts or with a thin layer of beach sand, gravel and cobbles possibly derived from the erosion of material in the shorecliffs.

The limestone bedrock is similar to that found on-shore and may be encountered from 5 to about 40 feet below the lake bottom with thicker overburden found near the shore. The bedrock surface continues to slope down gently into the lake at about 20 feet per mile.

6.3.3 Seismology

Based on the seismic zoning map published by the Federal Department of Energy, Mines and Resources in 1969, and incorporated into the National Building Code of Canada, the Darlington site is located within seismic zone 1 with minor earthquake damage probability. The probable return period for a seismic shock with a ground acceleration equivalent to 3% gravity or less, is estimated at 100 years for Zone 1. The Darlington site could have lower acceleration than 3% gravity for 100 year return period.

6.3.4 Vegetation

The site area has been previously cleared of its tree cover for agricultural purposes. Several wooded and scrub areas exist on the site along with those trees which line roadways and property boundaries.

The commercial forest capability of the area ranges from land with no limitations to land with only slight limitations due perhaps to excessive soil moisture. In areas of drier soil, trees common to the area include white pine, red oak, white oak, sugar maple, beech, basswood, white ash and black cherry. On wet sites, white cedar and black ash are found with tamarack being found on very wet sites (28).

Typical vegetation found about the marsh areas include common cattail, sedges, grasses and rushes with duckweed and pond lilies found in the pools of the marshes (28).

6.3.5 Wildlife

The wildlife resource of this section of the Lake Ontario shoreline tends to be centred about the marsh areas near the site which open onto the lake. The waterfowl capability of these marshes is very good. The most numerous of the migratory waterfowl species include mallards, black ducks, scaup and Canadian geese. Darlington Marsh and Oshawa Second Marsh, noted for their waterfowl, lie partly within Darlington Provincial Park, to the west of the site. A controlled put-and-take pheasant hunt takes place yearly at Darlington Provincial Park. Oshawa First Marsh, further west, is also noted for its waterfowl. Two marshes to the east of the Darlington site (Bowmanville and West Side Marshes) are noted as well for muskrat trapping and have a high potential for wildlife viewing (28).

The immediate site area has only slight limitations with respect to its capability to support deer (white tailed) production. Other smaller mammals which inhabit the area include European hare, squirrels, various types of mice, groundhogs and striped skunk.

6.3.6 Recreational and Historical Significance

The Historical Sites Branch of the Ministry of Natural Resources has conducted a basic level inventory to determine whether the site has any historical significance. This investigation, completed during the summer of 1974, found that the site is of no historical importance. It was never occupied by aboriginal peoples due to several prohibitive factors such as the high shoreline bluff which prevents access to and from Lake Ontario, the lack of surface water and the heavy nature of the soil which made early agricultural pursuits very difficult.

With regard to recreation, the lakefront within the boundaries of the Darlington site property is not ideally suited for swimming or other water-oriented recreational activities. In fact, the shoreline has developed into a steep bluff due to rapid wave action erosion.

6.4 COMMUNITY AND LAND USE

6.4.1 Regional and Local Municipal Development

6.4.1.1 Residential Development

The site of the proposed station is located in the new Town of Newcastle, which was established upon formation of the new Regional Municipality of Durham on January 1, 1974. Bill 162 replaced 21 local municipalities with eight new area municipalities (Figure 6-7) and reallocated all municipal responsibilities between them and the Regional Municipality.

Rapidly escalating house prices, resulting from a shortage of dwelling units in Metro Toronto, have forced many people to relocate to the east and west, and commute to their place of employment. The new Town of Newcastle has experienced a significant amount of this new housing demand with resulting extensive residential construction activity.

A brief description of communities is as follows:

(i) New Town of Newcastle

This municipality was established on January 1, 1974, as one of eight new area municipalities within the new Regional Municipality of Durham. It was formed by the amalgamation of the Townships of Darlington and Clarke, the Town of Bowmanville, and the Village of Newcastle. The total 1971 population of the amalgamated municipalities was over 27,000.

Various large housing projects have been proposed for this Area Municipality including an 800-home subdivision in the southeast corner of Port Granby, a 1000-home subdivision just west of the community of Newcastle, and 40-50 homes near Eniskillen. All are subject to approval by both the Area and Regional Municipalities.

(ii) Community of Bowmanville

This community, formerly incorporated as a Town, is the only large urban centre within five miles of the proposed station. Its population (8950 in 1971) is presently growing rapidly due to the construction of several large housing subdivisions. Housing projects, either under construction or already approved, are likely to cause existing sewage and water treatment facilities to reach their capacity much sooner than originally planned by the community (see Section 6.4.1.2).

FIGURE 6–7 REGIONAL MUNICIPALITY OF DURHAM

(iii) City of Oshawa

The City of Oshawa, approximately six miles to the west, has become a major regional industrial/residential centre. Its 1971 population of 91,590 is expected to grow to 145,000 by the year 1986 and 200,000 by the year 2001.

According to the proposed Official Plan of the Oshawa Planning Area, the Oshawa and Whitby water supply systems are to be integrated within the next five years. This would ensure enough capacity to serve Oshawa's projected population for the next six to eight years. With regard to sewage treatment, the 1973 Industrial Survey of Ontario Municipalities, issued by the Ministry of Industry and Tourism, reports that this facility is already operating at close to capacity.

(iv) Community of Newcastle

This community, formerly incorporated as a Village, is located approximately seven miles east of the site. The population of this community was 1,940 in 1971. Almost 150 lots have recently been approved for construction of residential units but are awaiting extension of services. Many additional plans have been proposed for housing construction in this community, but have been hindered by unavailability of required sewage treatment and water supply facilities.

Water supply and sewage treatment facilities for the communities of Bowmanville and Newcastle, and for the City of Oshawa, are described in Table 6.16.

TABLE 6.16

Municipal Services
Water Treatment Facilities

Urban Centre	Source	Treatment	Total Capacity of Works (MGD)	1972 Avg. (MGD)	Remarks*
Bowmanville	1) Lake Ontario 2) Skinners Springs & Malkie Creek	Complete Chlorination	2.3	0.696	
Newcastle	One Municipal Well	Chlorination	0.144	0.05	1
Oshawa	Lake Ontario	Complete & Fluoridation	33.0	12.5	2

* Remarks

1. An additional well, which is designed to double the current capacity of water supply, is scheduled for operation in 1974.
2. Plans are being prepared for expansion due to anticipated population growth in coming years.

TABLE 6.16 (cont'd)

Municipal Services
Sewage Treatment Facilities

Urban Centre	Treatment	Effluent Discharge Point	Total Capacity of Works (MGD)	1972 Avg. (MGD)	Remarks**
Bowmanville	1) Trickling Filter 2) Activated Sludge	Soper Brook	1.5	1.06	
Newcastle	ISTS*				1
Oshawa	1) Trickling Filter	Harmony Creek	7.5	7	2,3
	2) Primary		5	2.9	

*ISTS - Individual septic tank systems

**Remarks

1. A new prefabricated combined extended aeration - contact stabilization type plant is under construction. Design capacity will be 0.28 MGD initially, 0.4 MGD ultimately.
2. Plans are to upgrade the Trickling Filter plant to a secondary treatment facility with a capacity of 12.5 MGD in 1975.
3. Oshawa also sends an average 0.5 MGD of sewage to a 2.0 MGD capacity secondary treatment plant in Whitby. Capacity of this plant will be doubled to 4.0 MGD in 1974.

6.4.1.2 Planned Development

The Darlington site is located in the recently-formed Central Ontario Planning Region whose boundaries are shown in Figure 6-8. This new Region is an enlargement of the former Toronto Centred Region (TCR) of which policies established to provide direction over future growth are still valid. The site is just within the eastern boundary of the primary development zone of the former TCR, the Lake Ontario Urbanized Area. The nearest urban centre to the site is the community of Bowmanville and the nearest regional centre is the City of Oshawa.

The Central Ontario Region also encompasses most of the former Lake Ontario Economic Region. A report prepared by the Ministry of Treasury, Economics and Intergovernmental Affairs (TEIGA) in June, 1972, entitled "Design for Development, Prospects for the Lake Ontario Region", briefly summarizes development trends in the area, and discusses three alternative techniques of shaping future growth. The report states that a trend has developed in the southern portion toward settlement by those who prefer to live in smaller communities and commute to larger centres. Bowmanville is a centre of much of this new growth. Furthermore, alternative patterns of growth suggested by the report all include Bowmanville and the project site area within a growth centre.

The Act to establish the Regional Municipality of Durham (Bill 162) dissolved all planning areas that were included within the boundaries of the new municipality. However, the Act also stipulates that all existing official plans are to remain in effect until amended or replaced by new plans to be adopted by the Regional Council.

On November 14, 1973, the Council of the former Township of Darlington, within which the site is located, adopted Amendment No. 8 to the Official Plan of the Darlington Planning Area. This amendment is still before the Ministry of Housing for approval. It is designed to guide development within the boundaries of the former Planning Area until 1976, when a Regional Official Plan is to be prepared for the new Regional Municipality of Durham.

Proposed Amendment No. 8 anticipates considerable pressures for urbanization in the Courtice, Mitchell Corners and Bowmanville areas (Figure 6-9). However, full municipal piped services will be required before any extensive development can proceed. Also, a number of potential estate residential areas have been designated in rural areas due to an existing demand for such development.

On April 2, 1973, the Ministry of Treasury, Economics and Intergovernmental Affairs approved a new Official Plan of the Bowmanville Planning Area for the purpose of guiding growth during the period up to 1986. This plan is designed basically to meet the needs of an anticipated population growth to about 15,000 by 1986. Although the availability of large amounts of accessible industrial land pose immediate prospects for higher industrial employment in this urban centre, the plan recognizes that the centre will probably continue to serve primarily as a dormitory for Oshawa.

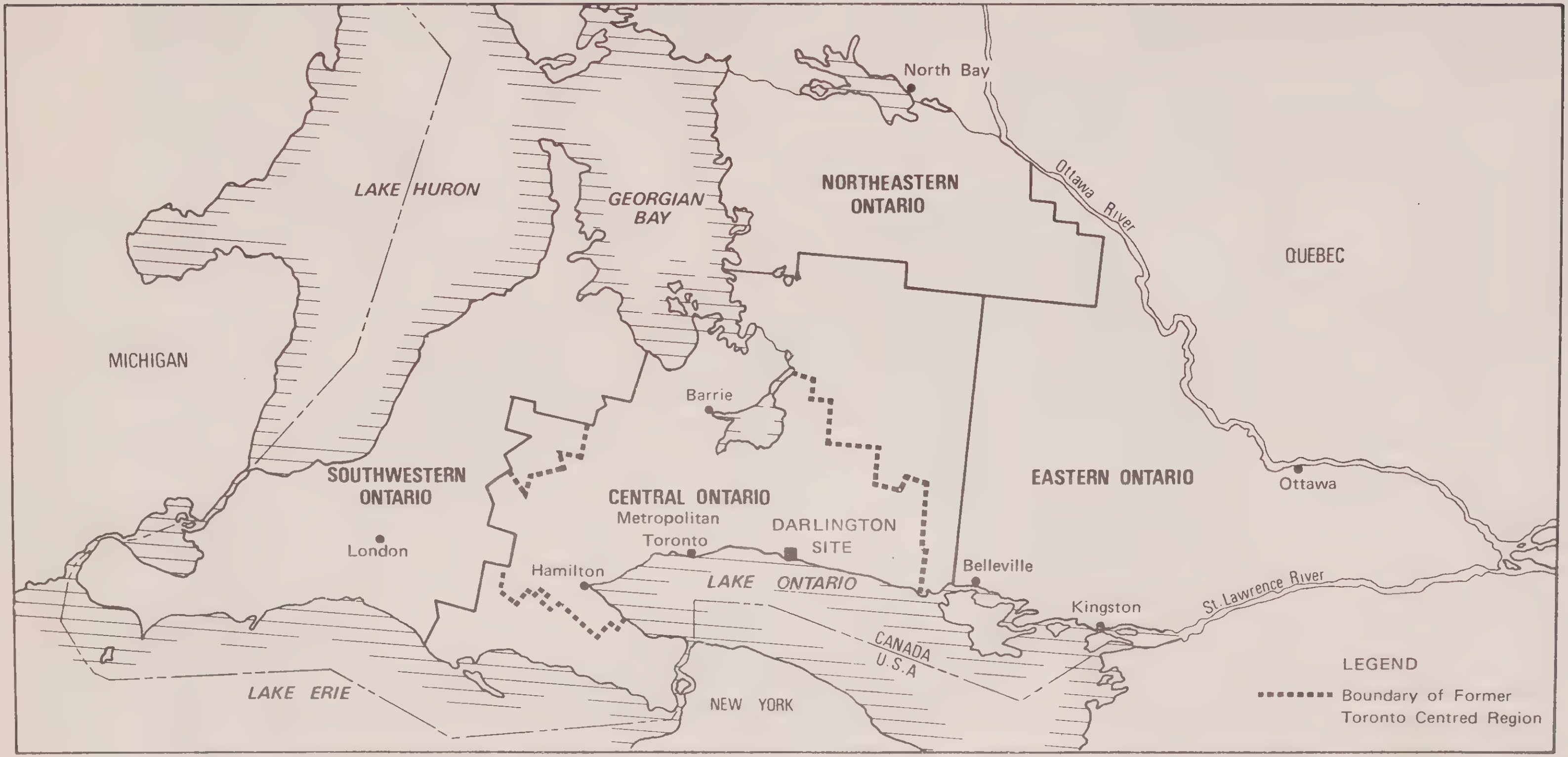


FIGURE 6–8 PROVINCE OF ONTARIO PLANNING REGIONS

FIGURE 6–9 PLANNED LAND USE

This plan also points out that the existing sewage treatment system is designed to serve a population of 15,000 and will have to be expanded when this population is exceeded.

It is now anticipated that when the subdivisions either already approved or under construction are completed by 1977-78, the 15,000 population figure will have been reached.

The community of Newcastle has no approved Official Plan but does have a Restricted Area By-Law to regulate land use. There have been several proposals by developers and landholders for major housing construction programs in this community, including some on lands now designated for rural use by the above By-Law. These have been hampered by the lack of an Official Plan for the community and by insufficient sewage treatment and water supply facilities to handle the increased demand.

According to a 1973 Water Supply Study (31) for the former Village of Newcastle, an Official Plan has been drawn up in draft form. It calls for a natural (gradual) growth rate of population in the community recognizing that the water demand to be generated by large scale housing construction projects would far exceed the capacity of existing and potential groundwater supplies. The Water Supply Study recommends that if any additional water supply is required, Lake Ontario is the best source. However, complete treatment would be required. The same study describes the sewage treatment plant, presently under construction, as having an ultimate design capacity to serve 5000 persons.

In 1973, the Council of the former Township of Clarke adopted an Official Plan for the Clarke Planning Area (still before the Ministry of Housing for approval). The purpose of this proposed plan is to provide a framework within which to control further development in the Planning Area. One major objective of the plan is the confinement of new, large-scale residential development to those areas that already have community facilities, the capability of economic servicing by public utilities, and the encouragement of economic and commercial activities. Furthermore, the taxation revenue from any new development must be sufficient to compensate for generated costs.

This plan has designated an area west of the Orono community as a "Special Policy Area" in which single-family, low-density development will be allowed, subject to approval by regulatory agencies. Also, a limited amount of estate residential development (2-acre minimum lot size) will be allowed in rural areas.

Also in 1973, the Council of the City of Oshawa adopted an Official Plan of the Oshawa Planning Area (awaiting approval by the Ministry of Housing) to guide further urban development. Objectives of the Plan include ensuring compatibility of adjacent land uses, proper distribution of types and intensity of new development such that they conform to regional planning objectives and place no burden on transportation and servicing systems, and avoiding adverse effects on the environment by the development and operation of land uses.

6.4.2 Population

Figure 6-10 identifies the urban areas within 25 miles of the site. Permanent population estimates for 1971 and predictions for 1986 and 2001 are presented in tabular form. These are listed for intervals of 5-mile radii from the site.

The 1971 population estimates are based on the 1971 Census of Canada using enumeration area populations provided by the Ontario Statistical Centre of the Ministry of Treasury, Economics, and Intergovernmental Affairs.

Figure 6-10 presents the forecasted population distribution within a 25-mile radius of the site for the years 1986 to 2001. These estimates were based on projected capacities as given by the Metropolitan Toronto Planning Board(32), populations for the year 1981 projected by the Metropolitan Toronto Transportation Plan Review(33), populations for the year 2001 projected by the Oshawa Area Planning and Development Study(34), and population projections to the year 2000 by the Proposed Official Plan of the Oshawa Planning Area(35).

6.4.3 Industry

Proposed Amendment No. 8 to the Official Plan of the Darlington Planning Area(36) designates most of the land area along the Lake Ontario shoreline between the Bowmanville community and Darlington Provincial Park for industrial use, Figure 6-9. A large cement plant and quarry already adjoin the eastern boundary of the Darlington site.

Industry in the Bowmanville community has primarily been in the form of light to medium manufacturing. The two largest plants produce rubber products and iron castings respectively.

The City of Oshawa has become a major centre of heavy manufacturing activity with approximately 90 manufacturing plants employing over 20,000 people. The largest segment of this employment is associated with the automobile manufacturing industry.

A preliminary survey has determined that there are no producing natural gas wells within 25 miles of the site. Furthermore, sand and gravel are the only minerals that are extracted from the earth within the 25-mile zone.

6.4.4 Agriculture

The general area in which the site is located has developed a trend toward rapid urbanization, as housing shortages and high prices in the large centres of Toronto and Oshawa have forced people to relocate elsewhere and commute to work. This trend is causing a gradual

reduction in farmland as increasing property values make subdivision development a more economically feasible venture.

Agricultural data for 1971 was provided by the Economics Branch of the Ontario Ministry of Agriculture and Food, and is listed in Tables 6.17, 6.18, 6.19.

TABLE 6.17

AGRICULTURE

Agricultural Land Use
Within 5, 10 and 15-Mile Radii of Site

1971 Census of Agriculture

Land Use	0-5 Miles (acres)	0-10 Miles (acres)	0-15 Miles (acres)
Cropland	5976	23889	44807
Summer Fallow	328	626	1379
Improved Land For Pasture	1569	7138	15518
Other Improved Land Area	321	1205	2364
Total Improved Land Area	8192	32856	64068
Woodland	368	2867	7457
Other Unimproved Land Area	1666	7192	17772
Total Unimproved Land Area	2034	10060	25229
Total Farm Area	10227	42917	89295

MILES FROM PLANT	ESTIMATED POPULATION		
	1971	1986	2001
5	15,000	35,000	70,000
10	120,000	180,000	300,000
15	150,000	300,000	500,000
20	190,000	400,000	630,000
25	260,000	600,000	900,000

FIGURE 6–10 POPULATION PROJECTION

TABLE 6.18

AGRICULTURE

Acreage of Selected Crops
Within 5, 20 and 15-Mile Radii of Site

1971 Census of Agriculture

Crops	0-5 Miles (acres)	0-10 Miles (acres)	0-15 Miles (acres)
Spring Wheat	15	65	99
Winter Wheat	67	252	523
Oats for Grain	443	1723	3494
Barley	193	1092	2243
Rye	4	110	342
Total Mixed Grains	722	3181	6608
Dry Field Peas & Beans	138	188	189
Corn for Grain	833	3258	5407
Corn for Silage	351	2489	4528
Alfalfa & Alfalfa Mixtures	732	4764	11087
Other Tame Hay	1175	3241	5857
Oats for Hay	33	179	317
Soybeans	103	124	134
Potatoes for Sale	13.6	26.2	48.8
Tobacco	14.9	218.9	450.3
Fruit Trees	365.4	1465	1647
Small Fruit	15	29.8	41.1
Total Vegetables	748.8	1240.3	1385.1

TABLE 6.19

AGRICULTURE

Selected Livestock & Poultry
Within 5,10 and 15-Mile Radii of Site

1971 Census of Agriculture

Stock	0-5 Miles (number)	0-10 Miles (number)	0-15 Miles (number)
Total cattle and calves	2386	11448	22682
Cows & heifers, 2 yrs & over	1319	5404	9968
Heifers, 1 yr & under 2	373	1718	3640
Steers, 1 yr & under 2	141	1724	3456
Bulls, 1 yr & over	31	130	280
Calves, under 1 yr	524	2470	5337
Cows & heifers (raised for milk)	774	3360	5655
Heifers, 1 yr & under 2 (raised for milk)	281	1035	1839
Total beef cows	546	2044	4312
Total pigs (all ages)	1733	5724	9736
Total sheep & lambs	426	1619	2693
Rabbits	106	408	1317
Total chickens pullets	142082	430447	500207
Total hens for egg production	56891	140019	183043
Mink	1219	26855	29175
Horses & ponies	111	410	758

6.4.5 Labour Market

The site is located on the eastern fringe of the "Golden Horseshoe" of communities along the northwest shore of Lake Ontario. This region is the industrial centre of Canada and, consequently, has the largest concentration of skilled labour in the country.

6.4.6 Education

Portions of two Educational Regions are included in a 25-mile radius of the site. The director of Region 9, Eastern Region has jurisdiction over the new Town of Newcastle and the Counties of Northumberland and Peterborough. The director of Region 8, East Central Region has jurisdiction over the rest of the Regional Municipality of Durham, Metropolitan Toronto, and the Regional Municipality of York.

The school board within whose jurisdictional boundaries the site is located has recently been renamed to the Northumberland and Newcastle Board of Education. It includes the County of Northumberland and the new Town of Newcastle.

In the 1972/73 school year, there were 22 public schools, 3 secondary schools, 1 separate school and 1 school for the trainable retarded in the new Town of Newcastle.

6.4.7 Medical

According to the 1973 Canadian Hospital Directory, the nearest hospital to the site is Bowmanville Memorial Hospital in the community of Bowmanville, having a medical/surgical capacity of 88 beds. A greater variety of services are provided at Oshawa General Hospital in the City of Oshawa, which has a medical/surgical capacity of 325 beds.

6.4.8 Transportation

The general area of the site is well served by transportation facilities. These include two provincial highways, a railway, a regional airport and Lake Ontario.

The MacDonald-Cartier Freeway (M/C Freeway) and Highway 2, both serve the area. Municipal roads then provide direct access to the site. The M/C Freeway has two interchanges nearby: one about two miles to the east, and the other the same distance to the west of the site. These interchanges connect to a paved, two-laned, light-service road which intersects with another local road that provides access to the site (Figure 6-11).

The area is also served by the Canadian National Railway line south of and parallel to M/C Freeway. This line bisects the Darlington property.

6.4.9 Recreation and Parkland

6.4.9.1 Present

The main recreational facility of the area is the 380-acre Darlington Provincial Park immediately southeast of Oshawa and three miles west of the proposed station site. It is a popular facility, having had over 215,000 visitors in 1972. It features 368 campsites, swimming facilities, fishing, controlled hunting, boating, etc.

Also, within 25 miles of the site are eleven Conservation Areas: three within the Metropolitan Toronto and Region Conservation Authority, four within the Central Lake Ontario Conservation Authority and four within the Ganaraska Conservation Authority (Figure 6-12).

In addition to these facilities, there are numerous golf courses, local parks, swimming areas and snowmobile trails. A 45-acre zoo is located within the community of Bowmanville.

There are no provincial wildlife sanctuaries within 25 miles of the site. There are, however, three wildlife management areas (controlled hunting) including one in Darlington Provincial Park (Figure 6-12).

For a complete listing of recreational facilities within 25 miles of the site, refer to Table 6.20.

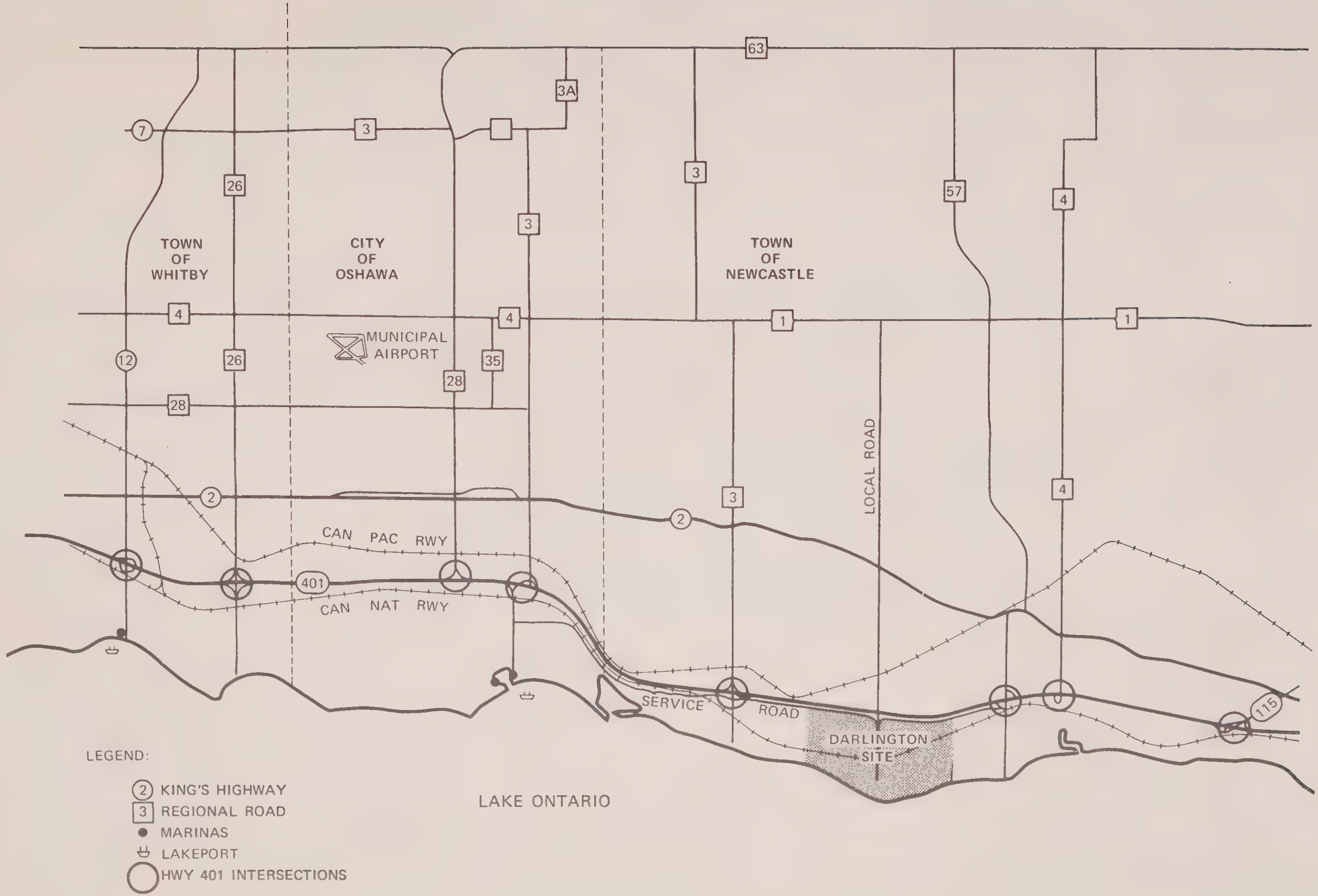


FIGURE 6–11 TRANSPORTATION

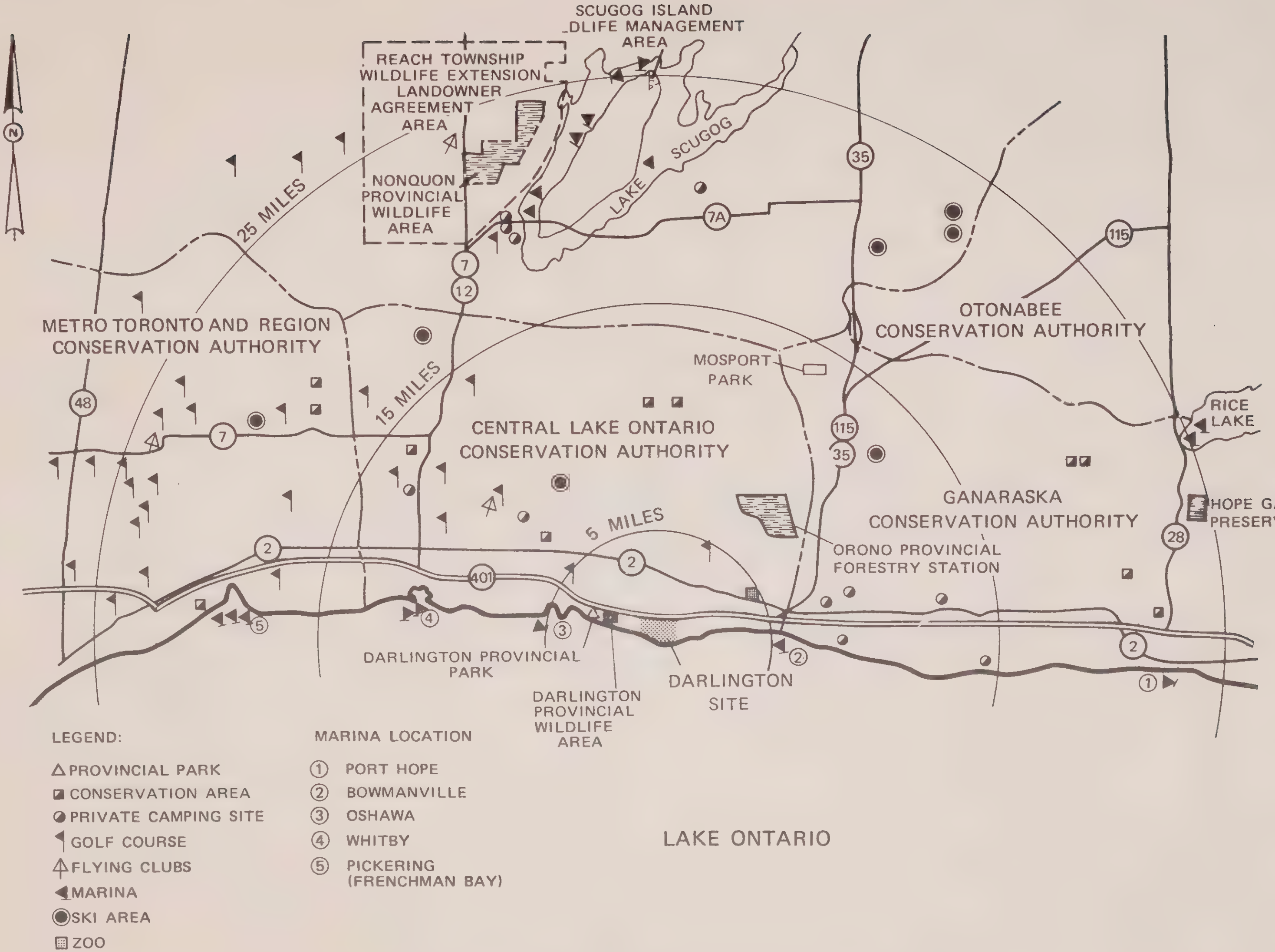


FIGURE 6–12 RECREATIONAL AREAS

TABLE 6.20

RECREATION AREAS WITHIN 25 MILES OF THE PROPOSED PROJECT

Distance (mi.)	Description
0-5	Aldian Snowmobile Hill
	Bowmanville Zoo
	Darlington Provincial Park
	Erinli Golf and Country Club
6-10	Bowmanville Country Club
	Enniskillen Conservation Area
	Harmony Valley Conservation Area
	Newcastle Golf Course
	Newcastle Trailer Park
	Oshawa Golf Course
	Oshawa Yacht Haven
	Oshawa Municipal Airport
	Samac Camp (Boy Scouts Canada)
	Waltona Park
11-15	East Shore Marina
	Fantasyland Park
	Heber Down Conservation Area
	Kendal Recreation Area
	Long Sault Conservation Area
	Marydale Park
	Mosport Park
	Oshawa Kirby Ski Club
16-20	Annandale Country Club
	Birdseye Centre Park
	Cherry Downs Golf Club
	Claremont Conservation Area
	Dagmar Ski Club
	Dean Hill Conservation Area
	Garden Hill Conservation Area
	Goreski's Summer Resort
	Greenwood Conservation Area
	Island Marina
	Keen Kraft Marina
	Lake Scugog Marina
	Lower Rouge Conservation Area
	Poplar Park
	Scugog Camp (United Church Canada)
	Sylvan Glen Conservation Area
	Thunderbird Golf and Country Club

TABLE 6.20 (cont'd)

RECREATION AREAS WITHIN 25 MILES OF THE PROPOSED PROJECT

Distance (mi.)	Description
21-25	Beacon Marina
	Beverly Park
	Blue Heron Park
	The Caribou
	Coppins Marina
	Dalewood Golf and Curling Club
	Devils Elbow Ski Area
	Durham-Ganaraska County Forest
	Glen Cedars Golf Club
	Greenbank Airport
	Lake View Camp
	Lakeview Marina
	Merry Mac's Camp
	Millbrook Provincial Fishing Area
	Moodies Trailer Park
	Moore Haven Marina
	Mountain's Marina
	Nonguon Provincial Wildlife Area
	Pickering Golf Club
	Pleasant View Marina
	Poplar Inn Marina
	Port Hope Conservation Area
	Reach Township Wildlife Extension Landowner Agreement Area
	Rice Lake Garage
	Skeena Marina
	Toronto Markham Airport
	Wallace Point
	Whitevale Golf Club

6.4.9.2 Future

A 200-acre addition is planned for Darlington Provincial Park for the near future. It would be located between the present west boundary of the park and Second Marsh in Oshawa. Facilities in the addition would be "urban-oriented" and include swimming pools and tennis courts. Second Marsh would be designated as a bird sanctuary.

The proposed Official Plan of the Clarke Planning Area indicates that a new 2 to 5-acre neighbourhood park is planned for the community of Newtonville approximately 14 miles east of the site.

6.4.10 General Land Use

6.4.10.1 Site

Almost all of the land within the site boundary is rated as having Class 1 soil, with no significant limitations for use in crop production (44). With good management practices, soils under this classification are moderately high to high in productivity for a wide range of field crops. A small portion of the site, near the west boundary, is located in an area that has 70% Class 1 and 30% Class 3E soils. The latter classification identifies soils that have moderately severe limitations restricting the range of crops or requiring special conservation practices due to past erosion damage.

The shoreline of the site is rated as having moderately low capability for outdoor recreation, and the remainder of the property as having only a low capability for such activity (45).

A field investigation of present land use within the site boundaries was carried out by Ontario Hydro in June 1974. Observed general land use is indicated in Figure 6-13. The field survey indicated that, at present, almost half of the site area is in pasture for cattle. The remaining portion of land is either under cultivation, wooded, or allocated to small orchards. There are approximately 20 houses presently on the site property, the majority of which appear to be in good repair. Several farm buildings are found with some of these houses.

6.4.10.2 Transmission System

The subject of the transmission system has been separately examined by the Solandt Commission.

6.5 NOISE

To the north of Darlington GS A, where the property line is situated near the MacDonald-Cartier Freeway, the normal traffic noise will

greatly exceed the noise emanating from the plant. To the east and the west of the station, the property line is situated about a mile away in either direction. The presently existing normal background noise levels at this line would probably average about 40-45 dbA during daytime and 35-40 dbA during nighttime.

6.6 STUDIES IN PROGRESS

6.6.1 Radioactive Emissions

A pre-operational monitoring program has as yet not been fully established. The pre-operational surveys planned for the site include the monitoring of baseline radiation and radioactivity levels as well as their seasonal variations. Also included are surveys of the local environment and population to establish critical exposure pathways, critical groups and to help select appropriate sampling media for the post-operational monitoring program.

6.6.2 Non-Radioactive Emissions

During and after site acquisition, preliminary studies of biological, water quality, hydrological and geological conditions were carried out in the area which was expected to be occupied by the proposed generating station and the thermal discharge from it. The data from these studies, together with data from studies carried out at other sites or existing stations on Lake Ontario, have been incorporated in this document of the site area. The object of studies during the conceptual design and preliminary engineering phases of the project development will be to obtain further environmental data which may influence design and operation of the station. It is expected that a pre-operational study phase will start approximately three years before the first unit is scheduled to come into service in order to provide baseline information for comparison with post-operational conditions.

In conjunction with the concept to develop uses for the warm water discharge from the station (Section 9.3), an aquatic biological program is now being carried out to determine the potential Cladophora growth problem and the changes in shoreline productivity.

7.0 ENVIRONMENTAL CHANGES DUE TO CONSTRUCTION

7.1 AIR

7.1.1 Quality

Local on-site emissions will include dust and airborne particulates from excavation and filling operations and any rock crushing. Off-site sources will include airborne particulate matter generated by heavy traffic over roadways and dust produced by trucks transporting material on and off the station site.

Dust may be produced along various trucking routes over which construction materials, particularly aggregate, ready mixed concrete and heavy rock fill will be delivered to the site.

Open fires or incinerators for the burning of construction material are potential sources of particulate matter. Such operations will conform to the requirements of the regulatory agency.

It is concluded that air quality should not be altered appreciably during construction, and that any changes will be temporary and localized.

7.1.2 Effects

Effects of atmospheric emissions generated on-site on the immediate area surrounding the property will be limited to particulates. Dust in the presence of free moisture will form a crust on surfaces of vegetation. Data have been documented on the detrimental effect of dust on vegetation (37). During the construction stage, the dust generated off-site along the trucking routes will be more of a nuisance than a damage problem. The problem will be minimized by keeping roads near the site free of heavy deposits and by using covered trucks where possible. Dust generated on-site should not cause damage off-site. Any effects will be visual and of a temporary nature.

7.2 WATER

7.2.1 Quality

The major impact on water quality is expected to occur from the construction of the proposed cofferdam required to extend the present shoreline. As described in Section 4.10.3, the initial phase of cofferdam construction will consist of dredging beneath the proposed cofferdam line to remove the permeable sand layer. This will be followed by the building of a rockfill core with an impermeable till seal on the land side. Some further dredging will be required for the

condenser cooling water discharge channel and the entrance of the intake tunnel.

The dredging of the fine sand layer from the route of the cofferdam will increase turbidity slightly. Studies at Lennox GS have shown that dredging and dumping of organic silty sand (7.5% organic matter) did not result in unacceptable turbidity (39). The dredged material will be dumped in the area to be reclaimed. The sandy nature of the dredged material should result in quick settling within the reclaimed area. No resolution of nutrients or other problem chemicals is expected due to the quality of the bottom sediments. Studies on the dumping of highly polluted silty material has shown 99% reduction in total solids, 97% in total phosphorus and heavy metal reductions approaching 100% after twenty hours of settling (48).

The construction of the cofferdam will have a long-term beneficial effect on water quality. At present, considerable erosion of the shoreline is occurring, resulting in secchi disc readings of one foot. The rockfilled cofferdam should stop shoreline erosion and significantly improve the clarity of the water. The armour stone protection and the rockfilled nature of the cofferdam should prevent addition to the littoral drift material.

The environmental implications of dredging and dumping operations for the intake tunnel and discharge channel are expected to be significantly less than at Lennox GS due to the different characteristics of the bottom material (39). The special precautions required at Lennox are probably not warranted at the Darlington site.

Discharge of sewage, surface drainage and commissioning chemicals may have a slight deleterious effect on water quality in a localized area. The sewage will be treated in stabilization lagoons designed to provincial Ministry of the Environment criteria. The surface run-off and ground water seepage will be drained or pumped to the lake. The water may be turbid at times but should clear quickly. The clarity of the water in the near-shore area should be better than at present due to the cessation of shoreline erosion. Fluorescein, morpholine and hydrazine are the major chemicals used during commissioning. These chemicals will be discharged to the sewage lagoon until a flow of condenser cooling water is available for dilution.

7.2.2 Aquatic Life

Extension of the present shoreline will remove an area of the lake bottom and therefore eliminate the benthic and other fauna normally associated with it. Partial replacement of biota will be achieved by colonization of the armour stone around the extended site. Lower turbidity, due to shoreline stabilization, will tend to encourage growth of the alga Cladophora on the armour stone, particularly in the first years after construction when small amounts of leachable nutrients will contribute to growth. Cladophora growth, in turn, will encourage colonization by some benthic species and provide protection for juvenile fish. Break-off of Cladophora may cause slightly increased deposition rates along the adjacent shoreline.

Construction of the cooling water discharge channel and submerged offshore intake will require some drilling and blasting. Blasting will shock-kill fish and other organisms in the immediate area but noise and turbidity increases due to drilling may keep fish from the immediate area (50). Excavation and dumping will cause suspension of solid material in the adjacent waters and some solution of nutrient materials will occur. The localized, short term effects on water quality observed at the Lennox GS site (39) suggest that effects on biological life will be small in the affected area. The main effect will be on benthic fauna where sedimentation occurs. Such areas should be recolonized after construction activity ceases.

7.2.3 Shoreline Disturbance

The realignment of the shoreline may possibly result in a slight change in the direction of the lake current in the immediate site area. These effects will be studied using a hydraulic model. However, the new protected shoreline and stabilized shorecliff face will prevent further erosion in the vicinity of the site and will decrease the availability of littoral drift material from the area. The new shoreline, once stabilized, will act as a headland and may trap drift materials on either side to form beaches.

7.2.4 Ground Water

As stated in Section 6.2.6 the ground water level is at about 5 to 20 feet below the ground surface and there is a piezometric water level existing in the interglacial sands and silts layer, which is some 5 to 15 feet higher than the ground water level. These conditions will affect the safety and efficiency of excavation for the powerhouse yard in the form of possible seepage from the face and toe of the cut slopes and possible boils at the bottom of the excavation. These water levels will need to be lowered and the piezometric pressure released to ensure safe excavation. Preliminary studies show that the ground water level within a 1200 feet radius of the excavation will be affected by the lowering of the water levels in the area to be excavated.

7.2.5 Surface Drainage

Most of the drainage gullies and poorly drained areas are located near the east and west boundaries of the site and hence, are not affected by construction. However, a small gully occupied by an intermittent stream near Raby Head will be completely removed. This will not significantly affect the local drainage system as the gully is dry most of the year. In any case, the surface drainage system in the site areas south of the railway tracks will be considerably changed by the deep excavation for the powerhouse yard, and the installation of an artificial drainage system around the toe of the cut slopes.

7.3 SITE AREA

7.3.1 Site Clearing

Little site clearing is anticipated as most of the site has been previously cleared for general farming and dairying purposes. Those trees which lined former property boundaries and road allowances and a few orchards will have to be removed from the switchyard and powerhouse yard areas and along the transmission line egress. Efforts will be made wherever possible to maintain the remaining trees and shrubs within the site.

7.3.2 Site Grading and Shoreline Reclamation

Site grading will be confined primarily to that area of the site south of the CNR tracks. Extensive excavating and filling operations will be required to bring the switchyard and powerhouse areas to their proper grade levels. The shorecliff will undergo regrading to stabilize its slope.

Coarse rock for the cofferdam core, armour stone and filter material will be brought in from off-site sources. The backfill material will be obtained from on-site excavating operations. The effects of transporting rockfill and armour stone to the site for the cofferdam will include increased traffic congestion, noise and possible roadway degradation may occur along transport routes. Ontario Hydro is studying alternative means of transporting this material to the site to relieve this possible problem.

7.3.3 Wildlife

The wildlife resource of the area is centred about the marshes which open onto Lake Ontario. Wildlife disturbed by construction activities will be the migratory waterfowl species and other birds and small mammals common to the area.

7.3.4 Rehabilitation

On completion of construction activity the site area will be graded and sloped. Flat areas will be sodded and shrubs planted. Trees will be planted on road access routes and slopes will be planted with shrubs. Parking areas and roads will be paved.

7.4 COMMUNITY AND LAND USE

7.4.1 Population

The total construction force required for the proposed station is forecast to peak at a yearly average of 3900 in 1982. Of this total

approximately 25% are expected to relocate from beyond the commuting zone of the proposed project. For purposes of this report, the commuting zone is considered to be the area bounded by Metropolitan Toronto, Peterborough, Lindsay and Cobourg. It is expected that most of these relocated employees will seek board and lodging or rented family accommodation. Preference is likely to be given to Oshawa and the Town of Newcastle.

7.4.2 Industry

As previously noted, proposed Amendment No. 8 to the Official Plan of the Darlington Planning Area calls for most of the land area between the site and Darlington Provincial Park to be developed for industrial use (Figure 6-9).

Since there already is a shortage of labour in some trades, construction of the proposed station may further aggravate this problem for local industries.

7.4.3 Education

It is not anticipated that construction of the proposed station will cause any significant impact on existing or planned educational facilities.

7.4.4 Medical

No problems are anticipated in meeting the medical needs of the project construction forces and their families.

7.4.5 Transportation

Present plans indicate that project construction traffic from the MacDonald-Cartier Freeway will use two existing interchanges, No. 73 at Courtice Road (Durham Regional Road 3) and No. 74 at Waverly Road, two miles east of the site (Figure 6-11). From these interchanges, traffic will then proceed along the service road which runs south of and parallel to the freeway, to Holt Road. The latter is located approximately midway between the two interchanges, and will be rebuilt south of the service road by Ontario Hydro to provide direct access to the site.

The Courtice Road is considered inadequate to handle the heavy traffic to be generated by construction of the plant. Modifications would thus be necessary. The east-west service road to the site access road may also be inadequate for the construction traffic.

Railway traffic will be handled by a railway spur which will be installed to connect with the CNR line that bisects the Darlington property.

7.4.6 Labour Market

The proposed plant will be in strong competition for skilled labour with many other construction projects in the area. In addition to numerous projects to be undertaken by the private sector, two other generating stations are planned for construction by Ontario Hydro within 20 miles of the site: an oil-fired station at Wesleyville and another nuclear station at the Pickering site.

It is expected that many tradesmen will transfer from one generating station to another as the demand changes. The peak labour requirement occurs at different times for the three stations (Table 7.1).

There should be no problem in obtaining the required manpower for the civil portion of the construction project from within the previously defined commuting zone. However, some of the trades to be involved in the mechanical phase will be required to relocate from elsewhere. For example, it is estimated that only about 20% of the maximum requirement of over 900 steam and pipe fitters will be available locally.

With regard to construction management staff, most will already be residents of the commuting zone.

7.4.7 Recreation and Parkland

The construction of the proposed station is not expected to have any significant effect on recreational and parkland facilities.

TABLE 7.1

CONSTRUCTION MANPOWER REQUIREMENTS*
PROPOSED GENERATING STATIONS
LAKE ONTARIO SHORELINE

AVERAGE YEARLY CONSTRUCTION MANPOWER

YEAR	DARLINGTON GS	WESLEYVILLE GS	PICKERING GS B	TOTAL
1975	-	100	160	260
1976	100	470	780	1350
1977	130	1160	1840	3130
1978	170	1460	3000	4630
1979	750	1040	3080	4870
1980	1850	350	1990	4190
1981	3260	-	1020	4280
1982	3900	-	260	4160
1983	3400	-	-	3400
1984	2400	-	-	2400

*Based on following unit in-service dates:

Wesleyville GS: March 1979, October 1979, March 1980, October 1980

Pickering GS B: March 1980, January 1981, October 1981, July 1982

Darlington GS A: July 1983, April 1984, January 1985 October 1985

7.4.8 Historical Character

The proposed project will in no way affect the historical character at the site area (Section 6.3.6).

7.4.9 Regional and Municipal Development

The proposed project is compatible with regional and municipal development plans.

7.4.10 General Economy

Construction of the proposed station may benefit the Town of Newcastle by possibly stimulating industrial growth in the area of the site. Also, benefit would result from local spending by staff and visitors to the project, as well as from local purchases of parts and services for the project itself. See Section 4.9.1 for details on grant-in-lieu payments to be made by Ontario Hydro to the Town of Newcastle.

7.5 NOISE

Generally the noise at the construction site can be classified into two categories: continuous noise from diesel engines and impact noise from jackhammers, and pile drivers. Overall sound pressure levels will depend on individual noise spectra of the construction equipment and the relative location of different pieces of equipment at the site. During operation of certain pieces of construction equipment, the sound pressure levels in the work area could exceed 85 dbA. Since most construction will be about a mile away from the property line, construction noise is not expected to intrude on the surrounding community.

8.0 ENVIRONMENTAL CHANGES DUE TO OPERATION

8.1 AIR

8.1.1 Radioactive Airborne Emissions

During normal station operation, any chronic release of radioactivity to the atmosphere will be via short stacks. In the case of purges of areas having closed ventilation systems, the ejected atmosphere will be released to the environment via these stacks. In all cases, potentially radioactive effluents are monitored and, if necessary, filtered or retained by closing the exhaust duct dampers.

Since there is yet no operating experience at Bruce GS A, to which Darlington GS A will be similar, it is instructive to review the relevant operating experience of Pickering GS A, even though the Pickering and Darlington stations will not be identical.

Over the period of July 1971 to July 1974, there has been no noticeable change in the external gamma radiation background levels in the vicinity of the Pickering site that can be attributed to the station operation, rather than the variation in the natural background radiation levels. Several more years of data collection will be necessary to determine what effect, if any, Pickering GS is having on gamma radiation levels in the vicinity. Similarly, the gross beta activity in the air in the Pickering vicinity over the period from November 1970 to June 1974 has been, on an average, not significantly different from the provincial average. Tritium concentrations in air, above natural background levels, have been measured at the Pickering site boundary but concentrations have been approximately 0.1% of the maximum allowable. An environmental monitoring program is routinely carried out to confirm that any minor changes do not lead to unexpected consequences in the long term. Similar experience is expected for Darlington GS A.

The maximum permissible concentrations for various airborne radionuclides for continuous exposure (MPC_a) and the maximum permitted continuous release rates (DRL) derived from these MPC for Pickering GS A are presented in Table 8.1. The topography of the Darlington site is quite different from that of the Pickering site and because of the effect of topography on atmospheric dispersion, the DRL for the Darlington site may be different, but not substantially, from the Pickering DRL's. Also shown are the release limits corresponding to the design and operating target of 1% of DRL based on the dose to an individual at the site boundary. The last column in Table 8.1 lists the expected maturity average release rates for Darlington GS A based on the operating experience of Pickering GS A in 1973-1974 and neglecting the effect of the planned additional off-gas processing system (49).

TABLE 8.1

TARGET 7-DAY RELEASE RATES FOR AIRBORNE RADIONUCLIDES

Radionuclide	MPC_a (Ci/m^3)	DRL (Ci/7 days)**	Design Target*** 1% of DRL (Ci/7 days)	Expected release rates**** (Ci/7 days)
I-131	6×10^{-13}*	4×10^{-1}	4×10^{-3}	3.0×10^{-4}
H-3	3×10^{-7}	2×10^{5}	2×10^{3}	1.0×10^{3}
Particulates	1.5×10^{-12}	1.0	1.0×10^{-2}	7.0×10^{-4}
	$Ci\text{-}Mev/m^3$	Ci-Mev/7 days	Ci-Mev/7 days	Ci-Mev/7 days
Noble Gases	6.4×10^{-8}	4.3×10^{4}	4.3×10^{2}	7.0×10^{2}

* Based on dose of 1.5 rem to child's thyroid-uptake via food chain, open grazing of dairy herds 6 months per year.

** Based on a dilution factor at site boundary of Pickering GS A of 9×10^{-7} sec/m^3.

*** Actual averaging period for 1% DRL design target is one year. 1% DRL/7 days is shown strictly for comparative purposes.

**** Release rates assume no off-gas management installed, based on Pickering GS A experience to date.

Comparison of the last two columns in Table 8.1 indicates that the expected maturity releases are less than, or slightly greater than, the yearly average design targets, prior to the installation of specific waste management systems. Similar results are expected for Darlington GS A. Area monitoring will be carried out to ensure conformance with regulations and to detect any measurable additions to the background radiation levels due to the operation of the proposed station. Since the station is designed to meet the target of 1% of DRL, the dose to members of the neighbouring public, due to operation of the station, will be very small fractions of the maximum allowable, and will be similar to normal variations naturally occurring in the background radiation dose.

8.1.2 Non-Radioactive Airborne Emissions

The standby combustion turbine units will use light distillate oil (0.5% sulphur). It is estimated that each standby unit will operate approximately 600 hours/year. Approximately 33% of this time will be for routine testing on a regular basis to ensure that the units are always operable for their prime function, emergency power and safe, orderly station shutdown. The units can also provide peaking power if required.

These units will be designed to meet regulatory requirements. Ground level concentrations of atmospheric emissions will be well within regulatory limits.

8.2 WATER

8.2.1 Thermal Discharges

Hydraulic thermal model studies of plume dispersion are being carried out.

8.2.1.1 Modifications to Thermal and Current Regime

With the proposed types of intake and discharge structures, described in Section 4.7.4, it is calculated by mathematical model that the condenser cooling water will produce seasonal increases in lake surface temperature at full load as shown in Figures 8-1, 8-2 and 8-3. Under the prevailing westerly winds and the average wind speed for this wind direction, the outer limits of the thermal discharge (2F^{o} above surface ambient) will extend approximately 2-1/2 to 3 miles out into the lake in the spring, summer and fall and 2 miles in the winter. The surface temperature 10F^{o} above surface ambient conditions will extend about 8,000 feet in the winter, 7,000 feet in the spring and fall and 5,000 feet in the summer.

Under the seasonal conditions shown in Figures 8-1, 8-2 and 8-3, temperature changes will be detectable as much as 15 feet down from the surface. Under southerly or easterly wind conditions in the

spring and fall, surface temperatures of 61-65°F would extend along approximately 4,000 feet of shoreline and out into the lake the same distance. In the summer, a similar area would be exposed to mean seasonal temperatures in the range 71-75°F and for transient periods maximum temperatures in the range 85-90°F.

During periods when lake temperatures are above 39°F, the thermal discharge will be carried over the intake structure and no recirculation is expected. In the winter the thermal plume will tend to sink when the discharge water is cooled by evaporation or mixing to its maximum density at 39°F. Based on limited field data obtained at Pickering GS A, the water temperature under the surface plume was found to be 39°F or higher down to the bed of the lake. Beyond about 1,000 feet of the line along which the plume sank below the water surface, the plume had completely dissipated, there being no evidence of it at any depth. As the proposed intake structure of Darlington GS A will be located at approximately 4,000 feet offshore, recirculationn of water 3-5F° warmer than ambient may occur under certain wind and current conditions when the wind is from the west quadrant. Winds from the west quadrant occur during the winter about 40% of the time.

Currents near the intake will be modified locally by the intake flow. The depth of the intake and the velocity cap on the intake structure will ensure that current modifications at the surface will be small.

8.2.1.2 Ice

As described in Section 6.2.4 fast ice may extend as much as 100 feet from shore. Beyond this, slush or pancake ice may extend on occasion for a few miles. It is expected that the thermal discharge will normally produce an ice-free area in the vicinity of the cooling water discharge channel. The size of this area will vary depending upon station operating load, persistence of currents and winds, and severity of weather and ice conditions.

8.2.1.3 Water Quality

(i) Dissolved Oxygen

In the vicinity of the station site, dissolved oxygen is generally near or above saturation levels (Section 6.2.1.2). During the passage of water through the condensers under partial vacuum, it is not expected that large volumes of released gases will be withdrawn. Levels of dissolved oxygen are the result of thermodynamic factors such as gas solubility, and kinetic processes such as rate of oxidation of organic matter (BOD), rate of oxygen uptake by the sediments, photosynthetic activity, and rate of reaeration, each of which is temperature dependent. Predictions that thermal discharges would significantly lower the dissolved oxygen concentrations in low-BOD waters are generally not substantiated by data from recent studies (52, 53). Dissolved oxygen in the thermal plume area of an operating station on Lake Ontario was found to be similar to levels at the discharge point (54).

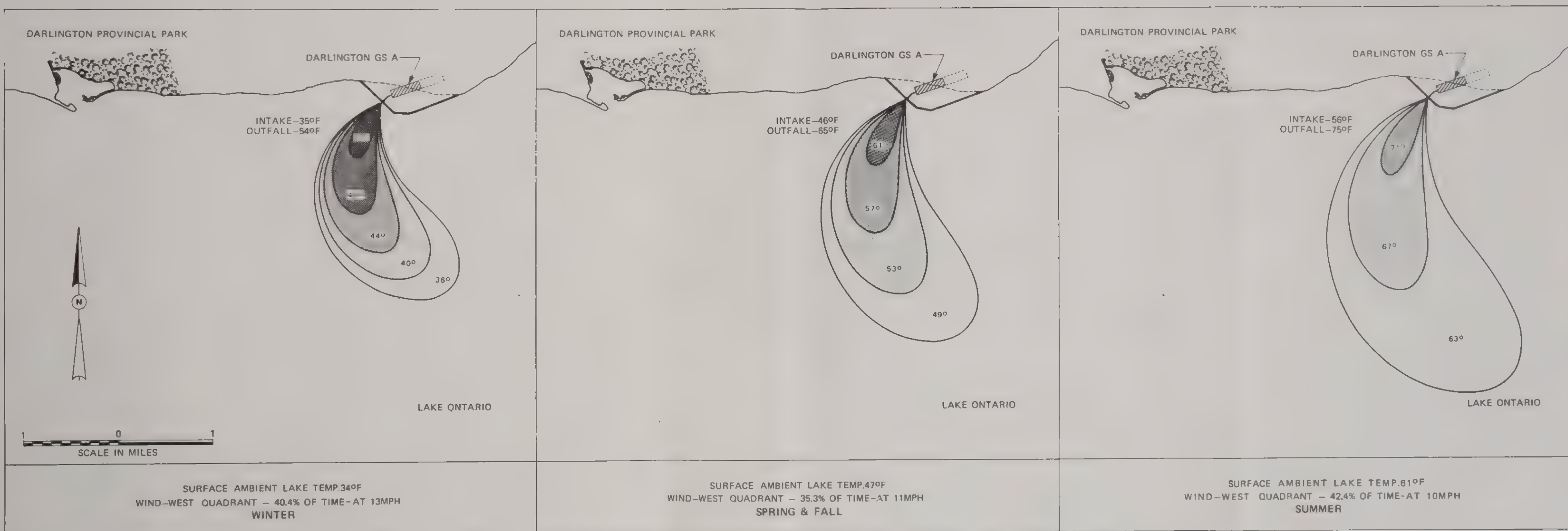


FIGURE 8–1
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WINDS FROM THE WEST QUADRANT
– DISCHARGE VELOCITY 4.4 fps

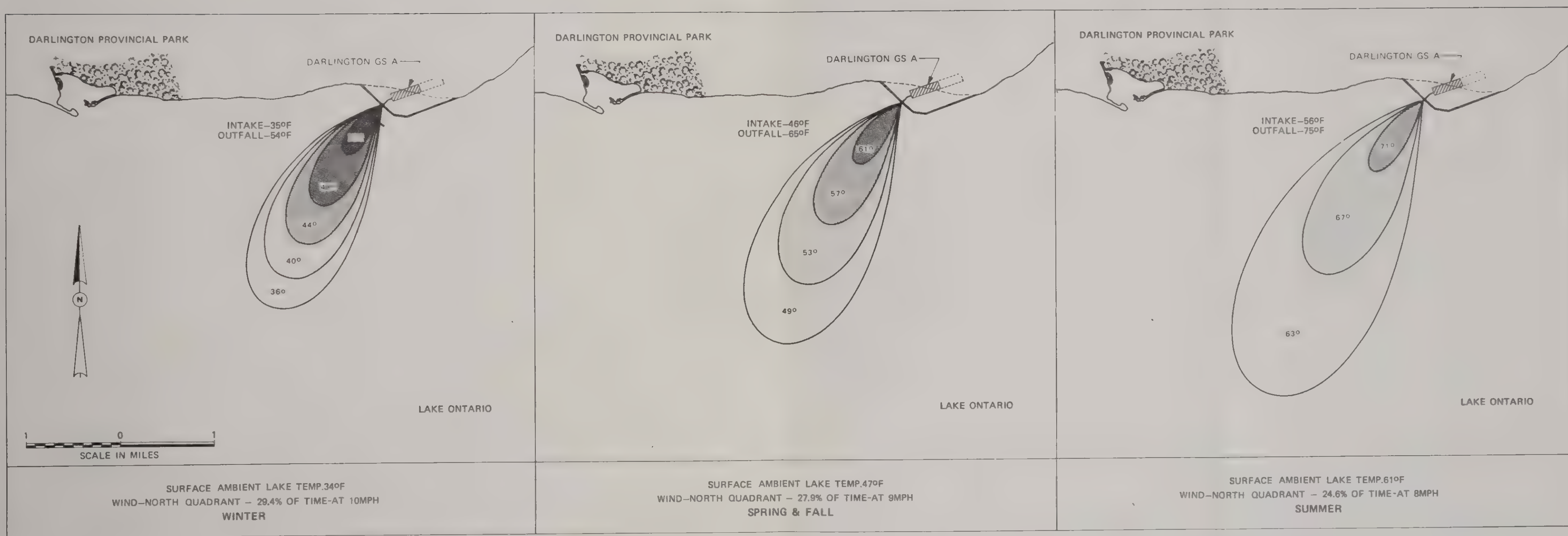


FIGURE 8–2
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WINDS FROM THE NORTH QUADRANT
– DISCHARGE VELOCITY 4.4 fps

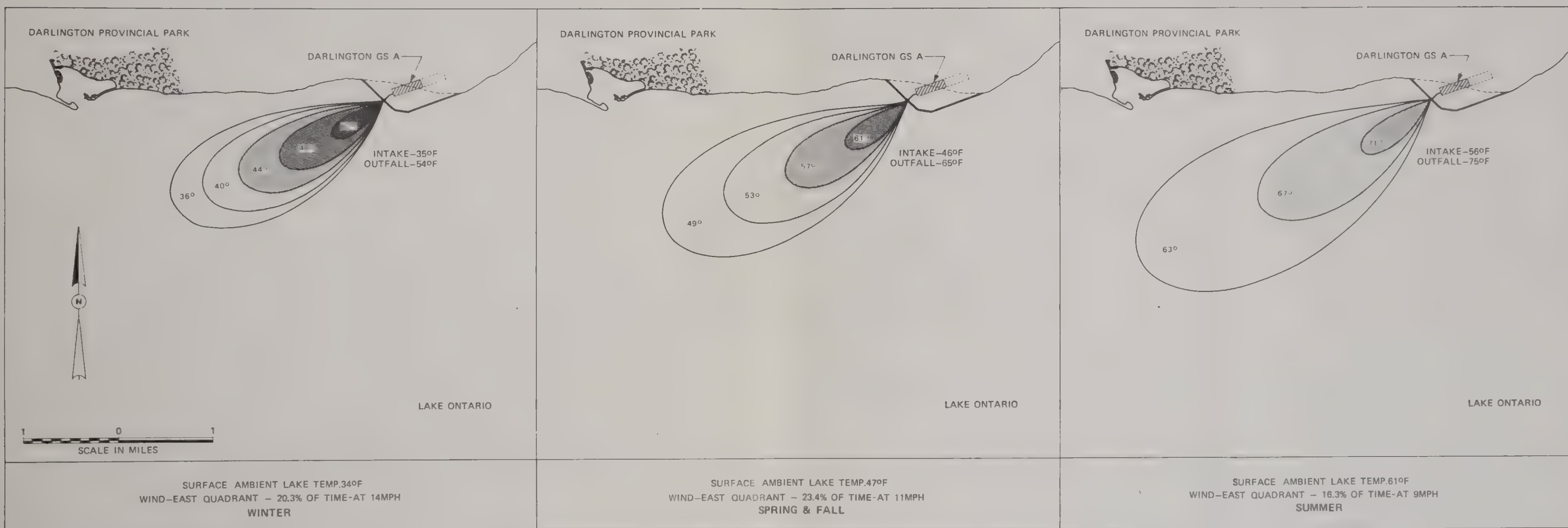


FIGURE 8–3
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WIND FROM THE EAST QUADRANT
– DISCHARGE VELOCITY 4.4 fps

(ii) Biochemical

A body of water containing biodegradable organic wastes, as indicated by the BOD level, may have adequate amounts of oxygen to maintain desirable fish life at one temperature, while at an elevated temperature the rate of oxygen consumption would be increased sufficiently to cause a critical depletion of dissolved oxygen. Such a condition would occur only if two other factors are also present:

(a) The intake waters of the generating station must have an organic load, such as when large amounts of untreated municipal and/or industrial wastes are discharged adjacent to the intake.

(b) The elevated temperatures must persist for periods of many hours to days. These two conditions will not occur at the proposed station (Section 6.2.1.2), and therefore the existing water quality is not expected to measurably increase the oxygen demand brought about by the transient elevated temperature in the thermal discharge area (52, 55, 56).

(iii) Nutrients

Nutrient enriched waters exposed to elevated temperature and sunlight may support excessive growth and standing crops of algae. Nutrient concentrations with depth display an inverse relationship to the temperature profile during stratification. Decreasing nutrient levels in surface waters during the summer months may limit phytoplankton responses. The nutrient content of waters obtained from a submerged offshore intake, at a nominal depth of 40 feet, is unlikely to either stimulate excessive phytoplankton development or have little effect on the growth of the more troublesome filamentous algae.

Dissolved oxygen levels in the intake area are well above the level of 1 ppm below which bottom sediments give up nutrients which would promote algal growth (135). The release of nutrients from entrained organisms to the discharge area may encourage the growth of heterotrophic slimes on structures near the discharge point.

8.2.1.4 Aquatic Life

(i) Direct Thermal Effects on Fish

During station operation, several factors will influence the offshore lake area heated by the condenser cooling water discharged at the shoreline. The heat content of the discharge will be directly related to station load. At any given load, climatological conditions such as winds and currents, will influence the position of the plume and its integrity. Ambient air and water temperatures, wind and relative humidity influence the rate of near-field cooling. In winter, stratification of the heated water on the lake surface will be diminished due to the reduced difference in relative density between

ambient and discharge temperatures. These factors, in conjunction with the large natural fluctuations in near shore temperatures (Figure 6-4), produce a thermal environment which tends to discourage fish from long term residence (59).

Most fish species are attracted to or repelled from a thermal discharge depending on their preferred temperature which is usually higher than the acclimation temperature. At any given time, adult fish will select their preferred temperature and be capable of moving in and out of the area influenced by the thermal discharge (58, 59). A final preferred temperature is reached for which avoidance is the expected response. Tables 8.2 and 8.3 list the acclimation temperatures, lethal temperatures and preferred temperature ranges for some Lake Ontario fish species. Preferred temperatures may markedly change during each season of the year and these changes may be independent of acclimation level (136). These data suggest that salmonids, in particular, choose a temperature range which will tend to discourage residence in the near shore waters in the summer. The known attraction of the alewife and, to a lesser extent, the Rainbow Smelt to thermal discharges is anomalous with these data (111). Juvenile fish may also not respond predictably to such temperature gradients and will be exposed to above-normal temperatures if the sustained swimming speed is great enough. The increased overall abundance of fish in the discharge area in the cooler months of the year may not only be due to higher temperatures, but to currents and increased food supply.

TABLE 8.2

ACCLIMATION, UPPER AND LOWER LETHAL TEMPERATURES OF FISH AND BENTHIC SPECIES FOUND NEAR THE DARLINGTON SITE

Species	Acclimation Temperature °C	Lethal Temperature Upper °C	Lethal Temperature Lower °C	References
Alewife	15	22.8		60, 61, 62
Yellow Perch	5	21.1		63
	10	25.0		63
	15	27.8		63
	25	29.4		63
juvenile	19	32.0		65
Carp	20.6	33.9		66
	26.1	35.6		66, 67
Smelt	-	21.7-28.3		69, 70, 71
Rainbow Trout	-	25.6		72, 73
	20	27.0		65
	25	32.8		70
Adult Steelhead	19	21.0		65
juvenile	18	26.5		65
Brown Bullhead	10	30.0		74
	25	33.8		65
	30	37.2		74
	34	34.8		65
	-	35.0		68, 75
Spottail Shiner	5	27.2		63
	25	31.1		63
	30	31.1		63
Coho Salmon	5	22.9	0.2	65
	10	23.7	1.7	65
	15	24.3	3.5	65
	20	25.0	4.5	65
	23	25.0	6.4	65
	-	25.0		76
Chinook Salmon	5	21.5		65
(juvenile)	10	24.3	0.8	65
	15	25.0	2.5	65
	20	25.1	4.5	65
	23	-	4.5	65
	24	25.1	7.4	65
White Sucker	5	26.1		75, 77
	10	27.8		77
	15	28.9		77
	20	28.9		77
	25	31.0		65
Common Shiner	5	26.7		77
	10	28.9		77
	15	30.0		77
	20	31.0		63, 77
	25	31.0		63, 77
	30	31.0		65
Emerald Shiner (juvenile)	25	30.7		65

TABLE 8.2 (CONT'D)

ACCLIMATION, UPPER AND LOWER LETHAL TEMPERATURES OF FISH AND BENTHIC SPECIES FOUND NEAR THE DARLINGTON SITE

Species	Acclimation Temperature °C	Lethal Temperature Upper °C	Lethal Temperature Lower °C	References
Smallmouth Bass	20	32.2		63
Largemouth Bass				
juvenile	30	36.4		65
	35	36.4		65
adult	25	34.5		65
	30	36.4		65
Longnose Sucker	11.7	27.2		70
Sea Lamprey (larvae)	20	28.5		
Gizzard Shad	25	34.0		65
	35	36.5		65
Northern Pike	25	32.3		65
(juvenile)	30	33.2		65
Channel Catfish				
juvenile	26	36.6		65
	34	38.0		65
adult	25	33.5		65
Threespine Stickleback	19	25.8		65
Bluegill	25	33.0		65
	30	33.8		65
Brown Trout				
Early fry	6	22.0		65
Late fry	5	22.2		65
	10	23.4		65
	20	23.5		65
Lake Trout	8	22.7		65
	15	23.5		65
	20	23.5		65
Gammarus Fasciatus (amphipod)*	15	31.5		65

* 24 hour median tolerance limit

TABLE 8.3

ACCLIMATION AND FINAL PREFERENDUM OF FISH FOUND NEAR THE DARLINGTON SITE

Species	Acclimation Temperature °C	Final Preferendum °C	References
Yellow Perch	24.0	17.6-20.1	64
	25.0	24.4	63
juvenile	24.0	20.0-23.3	64
Carp	20.6	32.2	66
	26.1	32.2	66, 67
	-	32.0	65
Smelt	-	14.4	69, 70, 71
Rainbow Trout	-	13.9-17.8	72, 73
Coho Salmon	-	11.7-13.9	76
Common Shiner	20.0	30.0	63, 77
	25.0	30.0	63, 77
Smallmouth Bass	-	20.3-21.4	65
juvenile	-	27.8	61
Rock Bass	-	14.4-21.3	61, 78
Brown Trout	-	11.7-17.8	79, 61
Round Whitefish	-	11.1-17.2	80
White Perch	1.1	6.7	110
	25.0	35.0	110
	23.9	32.2	110
	30.0	31.1	134
Rainbow Smelt	5.0	4.0-5.0	91
	10.0	8.0-9.0	
Alewife	-	4.4-8.8	65
Lake Trout	-	8.0-15.5	65
Chinook Salmon	-	11.7	65
White Sucker	-	11.8-20.6	65
Gizzard Shad	-	22.5-23.0	65
Largemouth Bass	-	26.6-27.7	65
Channel Catfish	-	30.0-31.0	65
Bluegill	-	32.3	65

The data in Table 8.2 suggest that for a few days each year when the ambient surface lake temperatures are in the range of 24-27°C (75.2-80.6°F), many species, if acclimated to this temperature range, will be close to their upper lethal temperatures in the very localized discharge area. At ambient surface temperatures below this range the temperature of the thermal discharge may be below that which could be tolerated for non-salmonid species. Salmonids would be exposed to lethal temperatures if attracted to the plume from acclimation temperatures of 15-21°C. Netting results at the site have suggested that salmonids tend to be absent from inshore waters during the warmer months.

In order to determine direct thermal effects on a given fish species, it is postulated that fish will move from the lake surface ambient temperature to the warmest area of the discharge and remain there. Each fish species has a characteristic temperature range in which it will survive, the range being dictated by the physiological adjustments that can be made during the previous period at the acclimation temperature. This incipient lethal temperature is defined as the temperature at which 50% of the sample of individuals die. Acclimation to a higher temperature will raise the upper incipient lethal temperature, and the reverse holds for acclimation to a lower temperature. The ultimate lethal temperature is that where further acclimation cannot change the upper or lower incipient lethal temperature. For most Great Lakes species the lower ultimate lethal temperature is close to the freezing point.

Survival at a given incipient lethal temperature is a function of temperature and duration of exposure. The length of the time that 50% of the population can survive an extreme temperature T(°C) can be determined from a regression equation using experimental data. This equation is:

$$\log t = a + bT \qquad \text{equation 1 (81)}$$

where "a" and "b" are the time axis intercept and the slope respectively, and "t" is the exposure time in minutes. Because the equation has been produced from experimental data in which the temperature was fixed and the time allowed to vary, it cannot be used to predict the temperature of 50% survival at a fixed time.

The equation as stated predicts the time of 50% mortality which is obviously undesirable for protection of fish populations. It has been shown that a reduction in an upper lethal threshold temperature of 2 C° (3.6F°) results in no deaths for equivalent exposure time (82, 83).

The temperature-time equation incorporating the 2 C° (3.6F°) safety factor can be rearranged to yield:

$$1 \geq \frac{\log t}{a + b\,(T + 2)} \qquad \text{equation 2}$$

where the condition for survival is such that the right-hand side of the equation must not exceed unity.

The regression coefficients "a" and "b" for some fish species found off the Darlington site are given in Table 8.4. Using these data, the value of the quotient in equation 2 has been calculated for each month of the year using the maximum predicted temperature rise across the station, the mean monthly temperatures and a time period of approximately one week (10,000 minutes). These calculations indicate that at all times of the year these fish species would not be adversely affected by moving rapidly from the ambient mean monthly temperature to the maximum discharge temperature and remaining there. This conclusion is more readily observable if the thermal tolerance data and the surface and discharge temperatures are plotted on the same graph (Figure 8-4). Maximum mean daily variances are superimposed on the mean monthly temperatures of Figure 8-4. These indicate that some of the fish species concerned may succumb to the thermal effects if they are attracted to and retained at the immediate discharge point during those days of the month when maximum daily temperatures are recorded.

TABLE 8.4

DATA SUMMARY FOR CALCULATION OF FISH TIME TEMPERATURE EXPOSURES

Species	Acclimation Temperature °C	°F	Upper Lethal Threshold °C	°F	Coefficients a	b
Yellow Perch	5	41	21.3	70.3	7.0095	- 0.2214
	11	50	25.0	77.0	17.6536	- 0.6021
	15	59	27.7	81.9	12.4149	- 0.3641
	20	68	29.7	85.5	16.9037	- 0.4801
	25	77	29.7	85.5	21.2718	- 0.5909
Brown Bullhead	5	41	27.8	82.0	14.6802	- 0.4539
	10	50	29.0	84.2	16.4227	- 0.4842
	15	59	31.0	87.8	28.3281	- 0.8239
	20	68	32.5	90.5	23.9586	- 0.6473
	25	77	33.8	92.8	22.4970	- 0.5732
	30	86	34.8	94.6	24.2203	- 0.5917
White Sucker	5	41	26.3	79.3	33.6957	- 1.1797
	10	50	27.7	81.9	19.9890	- 0.6410
	15	59	29.3	84.7	31.9007	- 1.0034
	20	68	29.3	84.7	27.0023	- 0.8068
	25	77	29.3	84.7	22.2209	- 0.6277

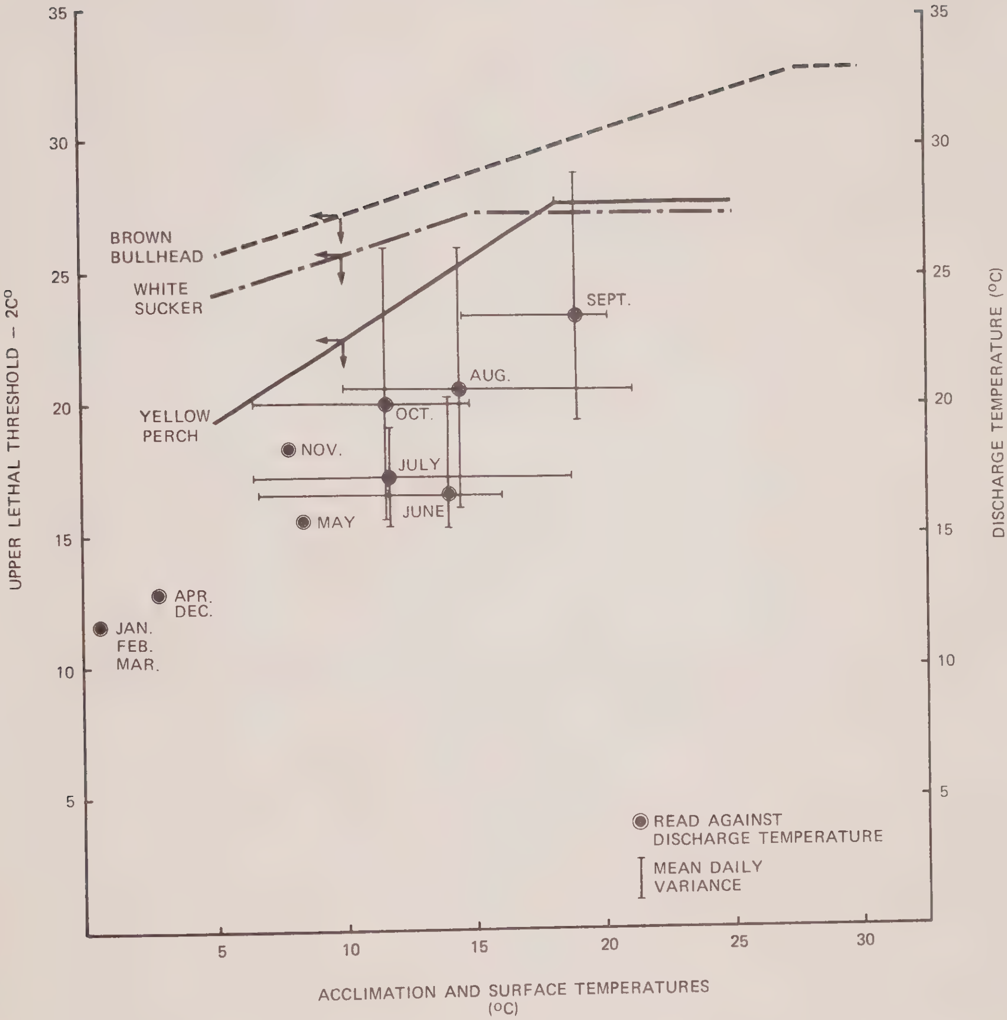


FIGURE 8–4 THERMAL TOLERANCE IN RELATION TO EXISTING LAKE AND DISCHARGE TEMPERATURES

However, death of fish due to elevated temperatures near the thermal discharge of generating stations is not a common occurrence (84, 85, 86), but records exist of death occurring when a plant shutdown exposes fish to a rapid drop in temperature (87). At acclimation temperatures of 10°C (50°F), most Great Lakes fish species would be able to withstand the drop in temperature down to the freezing point. Extreme temperature fluctuations in the discharge are not likely to occur because shutdown of all four units at any one time is only a remote possibility.

(ii) Fish Spawning, Growth and Migration

Spawning behaviour may be influenced by the temperature and current modifications in the area. The temperature requirements for reproduction and egg development in many species are confined to narrower ranges than for other physiological functions (88). Photoperiod effects and rising temperatures in the spring induce development of the gonads, and actual spawning is induced when a certain temperature range is reached. Generally, low temperatures during pre-spawning periods delay spawning, and higher temperatures hasten it (88, 79). Fish attracted to and retained in discharge channels may be induced to spawn earlier than might otherwise be expected. The young fish may then die if proper food is lacking at a critical stage of development (87).

The high silt content of the inshore water, due largely to shoreline erosion, in addition to the extreme exposure of the shoreline would suggest that present spawning capacity of the area is low. Fish numbers, measured by trap netting, were low (24). The area influenced by the low velocity, surface thermal discharge is predicted in Figures 8-1, 8-2 and 8-3 which indicate that surface temperatures will decrease to within approximately 2F° above ambient temperatures within approximately 15,000 feet of the discharge. Vertical temperature profiles taken at Pickering GS A show that the temperature at the 20 foot depth approached ambient at a distance of 2,000 feet from the discharge (90). By extrapolation, temperatures at 20 foot depth in the Darlington GS A thermal plume would approach ambient at approximately 3,000 feet from the discharge. This length of shoreline will be exposed to above ambient temperatures when onshore southerly or southeasterly winds occur. The natural fluctuation of the plume position under the influence of the currents and station load suggests that the influence on the natural shoreline temperature regime will be transitory and small compared with the naturally occurring temperature fluctuations shown in Figure 6-4. These thermal changes, in conjunction with the existing low capacity of the shoreline for spawning, would suggest that the influence on spawning capability will be small. The studies described in Section 6.6.2 will include a more detailed survey of the shoreline to the west of the station to determine its present spawning capacity and capability.

Based on observations at Pickering GS A (111), the thermal discharge is expected to attract fish, particularly the commonly occurring alewife and smelt, during the spring spawning period. Some delay in migration to spawning areas will occur but it is not known what influences there will be on spawning success or if spawning will be induced in the discharge area. Studies now being carried out on the

behaviour of the Rainbow Smelt in relation to thermal influences are expected to provide some of this information (89).

Thermal effects on feeding and growth have been observed at three Great Lakes generating stations. Conclusions were that fish were feeding equally actively in thermal discharge and control areas, although the type of food at each location may be different (58). Growth of fish may be adversely affected if the higher metabolic rate caused by increased temperature cannot be met by a higher food intake (87). However, more rapid growth may occur in a thermal discharge if an adequate food supply is available. This is the basis of numerous reports of fish culture in thermal discharges. In site studies involving the capture and measurement of hundreds of fish, no significant difference was found between thermal discharge and control area catches in length-weight relationships. With respect to length differences, however, there were significantly higher lengths among some of the more common species caught in the thermal discharge area. It was postulated that various factors other than heat may have caused these differences (58).

Fish migration in areas listed in Section 6.2.5.1 are not expected to be influenced by the thermal discharge from the proposed station. Existing data on fish intake however, indicate that some smelt and alewives may be prevented from completing their spring migration. This problem is expected to be reduced by the use of an offshore submerged intake.

(iii) Entrainment Effects

A review of literature on entrainment of organisms in generating station cooling water systems was recently carried out by Ontario Hydro. The review concludes that the extremely variable results obtained at generating station sites may be attributed to a number of experimental difficulties, such as the means of measuring mortality and sub-lethal effects leading to mortality, the additive or synergistic effects of pressure and mechanical damage, effects of biocides, and the accuracy of sampling before and after the condenser passage (92). The flow velocity entering the sampling nets also appears to critically affect the numbers of viable cells caught (57). Organisms entrained in the proposed cooling system will include phytoplankton, zooplankton, the free-swimming larvae of benthic invertebrates, fish eggs and larvae, and young fish. They will be subjected to a maximum temperature rise of 10.6C^{o} (19F^{o}). In addition to temperature shock, there will be mechanical abrasion and pressure change effects, and possible contact with chlorine if, and when, chlorination is required.

Little work has been done on fish inhabiting Canadian waters with respect to thermal tolerance during entrainment. Other information is available, however, to predict the effects of juvenile fish entrainment. In the condenser cooling water system, thermal shock is accompanied by mechanical stress. Of these two factors, mechanical stress appears to be the most important. It was found (93) that no young of nine species entrained in a nuclear power station's condenser cooling water system survived to the end of a 1.83 km (1.14 mile)

discharge channel when the water temperatures were above 30°C (86°F). Most of the dead fish were obviously physically damaged with greater damage apparent on larger fish. Other investigations (94) found that sudden temperature increases of 8.0C° (14.4F°) with a maximum temperature of 30°C (86°F) appears to be critical for survival of entrained fish. The maximum condenser cooling water temperature at the proposed outfall will, for the greater part of the time, be less than 30°C (86°F) thus allowing the majority of the entrained fish to survive temperature shock.

Other studies (95) have shown that King salmon and striped bass, both thermally sensitive species but not native to Lake Ontario, can survive temperature increases of 9C° (16.2F°) and 14C° (25.2F°) respectively for short time intervals such as 10 minutes with 95-100% survival.

Alewife and perch larvae, both extremely thermally sensitive, were observed to incur 65% mortality during a 93 second passage through a condenser cooling water system with a temperature differential of 7C° (12.6F°). In this case, a significant percentage of the mortality was thought to occur as a result of mechanical damage (96).

With respect to mechanical damage alone, limited evidence predicts a mortality range from 15% to 100%. Mortality of approximately 30% is probably more representative of the average losses to entrained fish (97). Entrained fish may be prone to increased predation (47).

Entrained fish which are too large to pass through the screens will be removed by the conventional screening system. Impingement on the screens and subsequent handling procedures will result in the loss of these fish. They will be gathered with weeds and other materials removed by the screens. The designed low approach velocity and offshore submerged intake is expected to reduce entrainment of adult fish to very small numbers.

Tests carried out at generating stations with once-through cooling systems have shown that, for temperatures below 34.4°C (94°F), little or no reduction in species composition of phytoplankton was observed (98, 99). Zooplankton passing through power station cooling systems showed no increase in mortality when subjected to a maximum temperature of 31.1°C (88°F) and a temperature rise of 10C° (18F°) (100).

Photosynthesis inhibition has been measured in phytoplankton when temperatures were raised from 23°C (73.4°F) to 30.8°C (87.4°F) (101). Some loss of mobility of zooplankton will occur but responses are variable (100, 102). Small fish and various motile larval forms will not be able to move against the approach velocity at the intake and will therefore be drawn into the intake structures.

(iv) Gas Bubble Disease

Symptoms of gas bubble disease have been reported among fish attracted to the thermal discharge from generating stations (103). This reported incident initiated a request from the Ministry of the Environment to measure dissolved nitrogen at the location of the Lennox GS intake to determine if gas super-saturation occurs. Surveys of fish that are in the discharge areas of other generating stations are now being made. Preliminary results show no evidence of gas bubble disease (104).

Most gas bubble disease reports have been associated with dam spillways. At a generating station, super-saturation may occur when water is subjected to increased temperature, decreased pressure or both.

(v) Benthic Organisms

The benthic community near the proposed station may be adversely influenced by chemicals, modifications to the thermal regime and the erosion of bottom sediments. On site investigations at the Pickering Station, which has a shoreline discharge structure and temperature regime similar to the proposed station, indicate that the number of taxa in the thermal discharge and control areas are generally similar, although the presence of one species, Gammarus fasciatus, at the locations closest to the discharge tended to produce the lowest diversity index, which, however, was not significantly lower than at other locations (105, 106, 107). Diversity at the closest station to the discharge has not been more variable seasonally than at other locations. There has been no elimination of species. A redistribution of numbers has occurred due to an increase rather than a decrease in abundance. No changes have yet been measured which can be regarded as irreversible or contributing to near shore instability of the ecosystem. It is expected that similar shifts in benthic fauna composition and populations will occur off the Darlington GS A discharge area. The upper tolerance limit of the majority of benthic organisms is close to 90°F, but above this temperature losses may occur (108). However, 90°F is the upper discharge temperature by design, and in general these temperatures do not extend to the lake bottom.

Some initial scouring and redistribution of the lake bottom sediments may occur in the near-shore discharge area which will result in a temporary loss of benthic organisms. When bottom sediments become stabilized it is expected that recolonization will take place.

(vi) Plankton

Studies have indicated that there is a high mortality in zooplankton entrained in condenser cooling water. While thermal shock is, in part, responsible for some deaths, mechanical stress appears to be the more significant factor (87). Tennessee Valley Authority biologists investigating zooplankton survival in the cooling system of the

Paradise Power Plant found that no zooplankton survived passage (109). Recovery of the populations was extremely fast downstream from the plant. This was attributed to seeding of the discharge water by organisms by-passing the power plant. The discharge water itself contributed to the recovery, having both a rich nutrient supply and slightly higher temperature which stimulated growth.

Effects on phytoplankton depend primarily on the ambient water temperature. An 8C$^{\circ}$ (14.4F$^{\circ}$) rise stimulated photosynthesis when natural water temperatures were 16°C (60.8°F) or cooler and inhibited photsynthesis when temperatures were 20°C (68°F) or warmer (101, 110). Mechanical damage in the condensers, however, often negated the temperature stimulation. Since the Darlington GS A intake water will be, for a great majority of time, below 16°C (60.8°F), little effect on the phytoplankton population of the Darlington site is envisaged.

The upper discharge temperature of approximately 30°C (86°F) can be expected to produce a species composition alteration among epiphytic algae to more thermally tolerant forms. In general, green algae will become dominant at the higher discharge temperatures with a possibility of a domination in the discharge channel of blue-green forms in August and September.

8.2.2 Miscellaneous Discharges

8.2.2.1 Radioactive Liquid Emissions

Because all liquid effluents from the station which might conceivably contain significant activity will be closely monitored and contained, it is extremely unlikely that the effluents will ever contain more than the allowable limit for continuous release during normal operating conditions. The maximum permissible doses for the public require the monthly average unidentified gross beta/gamma concentrations in all station liquid effluents not exceed 3.0×10^{-13} Ci/ml. Short term releases must not exceed 3.0×10^{-12}Ci/ml.

Experience at Pickering GS A indicates that calculated concentrations of tritium and gross beta in the condenser cooling water discharge, on a monthly averaging basis, have been small fractions of the maximum allowable. Background radiation levels in the aquatic environment in the immediate vicinity of the Pickering station have been little affected by station operation. An environmental monitoring program is routinely carried out to confirm that such minor changes do not lead to unexpected consequences in the long term. Experience similar to that at Pickering GS A is expected at Darlington GS A. Meeting the design targets will ensure that activity concentration levels in water available to the public will be small fractions of the maximum allowable.

8.2.2.2 Conventional Emissions

(i) Oil Wastes

Precautions will be taken to minimize the amount of oil reaching the lake. All oil storage will be located outside and will be diked to contain spillage. Floor drains from known oil handling areas will be directed to special sumps from which oil may be pumped out for disposal or treatment. A collection and separation system for any acute (fire spill) and normal oil leakages from the transformers adjacent to the powerhouse is being developed. The volume of any oil eluding the collection equipment should not cause noxious, toxic or nuisance conditions.

(ii) Commissioning Flushing

It is expected that morpholine and hydrazine will be added to demineralized water for flushing each unit. The Ministry of the Environment will be consulted on disposal methods in order that the impact on the aquatic environment may be minimized.

(iii) Water Treatment Plant Waste

The clarifier-softener blowdown will be routed by gravity through a settling basin. After settling has taken place, the liquid will overflow to the neutralizing sump. Tests carried out during 1970 and 1971 indicate that 80 to 90% of the suspended solids will have settled out during the first 24 hours after being discharged to the settling basin (111). The suspended solids consist mostly of calcium carbonate. The basin will be emptied every few years when the settled volume builds up, at which time approval for disposal of the solids will be obtained from the Waste Management Branch of the Ministry of the Environment.

A neutralizing sump serves to collect the backwash water from the sand filters and activated carbon purifiers and regenerant solutions from the ion exchangers. Neutralizing sump contents will be monitored for pH before discharge to the condenser cooling water discharge channel. A neutralizing agent will be added such that the sump effluent pH will be within the range 5.5 to 9.5 and the pH of the total station discharge is within 0.5 units of the natural lake pH.

The combined water treatment plant effluent is expected to be slightly acidic. It is preferable that the alkalinity of the lake water be employed to neutralize the waste instead of adding caustic thereby increasing the dissolved solids. With dilution in the cooling water discharge, it is not anticipated that any effect on the water quality will be discernable.

(iv) Boiler Blowdown

The analysis of the boiler blowdown water under normal operating conditions is expected to be approximately as follows:

Morpholine	-	0.2 ppm
Hydrazine	-	0.05 to 0.5 ppm
Chlorides	-	1.0 ppm
Silica	-	2.0 ppm

With the elimination of continuous phosphate treatment of boiler water (Section 4.7.6.6), it is expected that the pH will be maintained somewhat lower than the range 9.3-10.3 originally proposed. At a blowdown rate of 0.1-0.3% of the steaming rate, dilution available from the cooling water discharge would be at least 10,000-fold. The effect of nitrogen in morpholine and hydrazine is therefore expected to be negligible.

(v) Condenser Cleaning

The requirement for condenser cleaning and the procedure involved in employing shock chlorination is discussed in Section 4.7.5.

(a) Toxicity Data for Residual Chlorine

Comprehensive reviews by the U.S. Environmental Protection Agency (E.P.A.) of the effects of residual chlorine on aquatic life have recently been published (112, 113). Table 8.5 summarizes the available data. A concentration-exposure time relationship has been developed by the U.S. E.P.A. (Figure 8-5). Like many toxic substances, the non-toxic chlorine level decreases as exposure time increases (short-duration toxicity threshold) until a value is reached which is non-toxic, regardless of exposure time (chronic toxicity threshold).

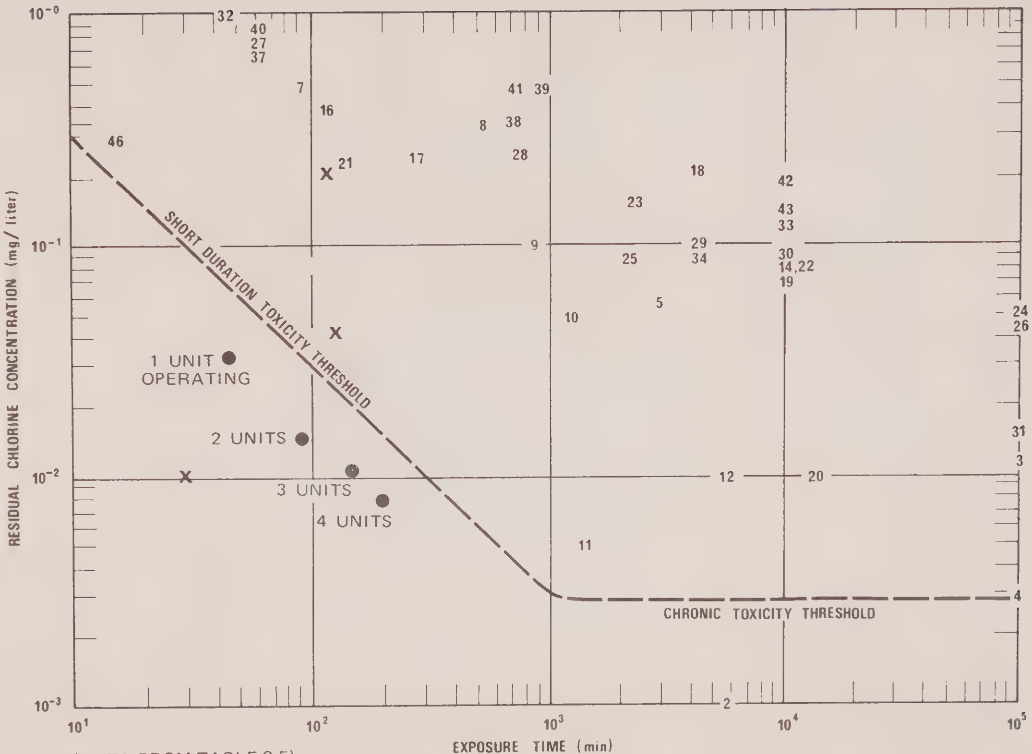
TABLE 8.5

EXPOSURES OF AQUATIC ORGANISMS TO TOTAL RESIDUAL CHLORINE (Ref. 112)

Species	No.	Effect Endpoint*	Concentration (mg/l)**	Ref.
Protozoa	1	Lethal	0.1	122
Caldoceran	2	Lethal (4 days)	-	118
Scud	3	Safe concentration	0.012	115
	4	Safe concentration	0.003	114
Trout Fry	5	Lethal (2 days)	0.06	119
	6	Lethal (instantly)	0.3	119
Brook Trout	7	Median mortality (90 min)	0.5	125
	8	Mean survival time (8.7 hr)	0.3	120
	9	Mean survival time (14.1 hr)	0.1	120
	10	Mean survival time (20.9 hr)	0.05	120
	11	Mean survival time (24 hr)	0.005	120
	12	67% lethability (4 days)	0.01	120
	13	Depressed activity	0.005	120
	14	7-day TL50	0.083	115
	44	Not found in streams	0.015	129
Brown Trout	45	Not found in streams	0.015	129
Fingerling Rainbow Trout	17	Lethal (4 to 5 hr)	0.25	127
Rainbow Trout	15	Slight avoidance (10 min)	0.001	126
	16	Lethal (2 hr)	0.3	127
	18	96-hour TL50	0.14-0.29	117
	19	7-day TL50	0.08	124
	20	Lethal (12 days)	0.01	126
Chinook Salmon	21	First death (2.2 hr)	0.25	123
Coho Salmon	22	7-day TL50	0.083	115
	23	100% kill (1-2 days)	0.13-0.12	123
	24	Maximum non-lethal	0.05	123
Pink Salmon	25	100% kill (1-2 days)	0.08-0.1	123
	26	Maximum non-lethal	0.05	123
Fathead Minnow	27	TL50 (1 hr)	0.79	116
	28	TL50 (12 hr)	0.26	116
	29	96-hour TL50	0.05-0.16	130-132
	30	7-day TL50	0.082-0.115	115
	31	Safe concentration	0.0165	114
White Sucker	32	Lethal (30-60 min)	1.0	121
	33	7-day TL50	0.132	115
Black Bullhead	34	96-hr TL50	0.099	115
Largemouth Bass	35	7-day TL50	0.261	115
	37	TL50 (1 hr)	0.74	116
	38	TL50 (12 hr)	0.365	116
Smallmouth Bass	36	Not found in streams	0.1	129
	39	Median mortality (15 hr)	0.5	125
Yellow Perch	40	TL50 (1 hr)	0.88	116
	41	TL50 (12 hr)	0.494	116
	42	7-day TL50	0.205	115
Walleye	43	7-day TL50	0.15	115
Miscellaneous	46	Initial kill (15 min)	0.28	128
	47	Erratic swimming (6 min)	0.09	128

* TL50 = median tolerance limit

** All concentrations were measured



(DATA FROM TABLE 8.5)

X CRITERIA SUGGESTED BY U.S.E.P.A.

FIGURE 8–5 TOXICITY OF RESIDUAL CHLORINE

The U.S. E.P.A. has suggested three possible criteria for intermittent chlorination (113):

(1) Total residual chlorine should not exceed 0.2 mg/l for a period of 2 hours per day for more resistant species of fish.

(2) Total residual chlorine should not exceed 0.04 mg/l for a period of 2 hours per day for trout and salmon.

(3) If free chlorine persists, total residual chlorine should not exceed 0.01 mg/l for a period of thirty minutes per day for areas with populations of trout and salmon.

These suggested criteria are depicted on Figure 8-5. There appear to be no experimental data to support the third suggested criterion (0.01 mg/l for 30 min.).

(b) Chlorine Residuals in the Discharge

Chlorine would be added such that a target residual of 0.2 ppm free chlorine would be available at the condenser outlet. It is standard design practice to arrange for chlorination immediately in front of the condenser face. This results in a reaction time of 10-20 seconds between application point and sampling point for control. This short contact time minimizes both the chlorine dose required and the level of combined chlorine residual (133). The resultant total residual chlorine consists mainly of hypochlorous acid, a form most readily reduced to chloride by the chlorine demand of the untreated water from adjacent units (133). The chlorine residual would be diluted by the untreated flow through the other sections (Table 8.6). An estimate of the residence time in the discharge channel is included in Table 8.6. It must be recognized that chlorine residual would be further reduced by the chlorine demand of the untreated water.

It is evident from Figure 8-5 that there is sufficient leeway between the diluted residuals and the toxicity threshold that the chlorination time and/or concentration can be increased in the event of unusually high fouling rates. Studies will be carried out at existing stations, including nearby Pickering GS A, to determine the potential of the unchlorinated cooling water for further reduction in the residual reaching the lake.

TABLE 8.6

CALCULATED CHLORINE RESIDUALS

No. of Units Operating	Chlorination Time (min)	Residual* (ppm Cl_2)	Reaction Time** Available (min)
1	45	0.033	20
2	90	0.017	10
3	145	0.011	7
4	180	0.008	5

* Based on dilution of 0.2 ppm residual free chlorine.

** Estimated residence time in the discharge channel during which residual chlorine should be reduced by the chlorine demand of the unchlorinated water.

8.2.3 Ground Water

The disrupted ground water regime during the construction phase will eventually become the new ground water regime in the area. The ground water levels within approximately 1200 feet of the excavation will remain permanently lowered. However, since the site boundaries are at least that distance away from any face of the excavation, it is expected that changes in the ground water regime outside the site boundaries will be minimal.

8.2.4 Surface Drainage

The surface drainage system in the site area during operation of the generating station is not expected to differ significantly from that at the end of the construction period. Surface water within the excavation will be collected in the artificial drainage system, treated if necessary, and then disposed of into the lake.

8.2.5 Water Use Compatibility

8.2.5.1 Industrial

There is very little industrial process water usage in the vicinity of the site. However, large amounts of cooling water, obtained from Lake Ontario, are used by the large cement company immediately adjoining the eastern boundary of the Darlington property.

8.2.5.2 Public

The closest municipal water intake and outfall is located at the community of Bowmanville, about three miles to the east of the site. Lake Ontario is used as both a supply of fresh water and receiver of the sewage treatment plant effluent.

Oshawa's water treatment and sewage disposal facilities also use the lake and are located approximately five miles to the west of the site.

In the community of Newcastle, a sewage treatment plant is presently under construction. Lake Ontario will be the receiver of effluent from the plant.

For complete statistics on intake and outfall flows, see Table 6.16.

8.2.5.3 Recreational

Darlington Provincial Park, two miles to the west of the site, provides boating facilities and a beach for swimming. Another

lakefront beach for swimming, West Side Beach, is located in the community of Bowmanville. Numerous marinas are also located along the lakeshore, the nearest in Oshawa Harbour, five miles to the west of the site (Figure 6-12).

8.2.5.4 Water Resources

Irreversible loss of water from the area will be confined primarily to an increased rate of evaporation during cooling of the thermal discharge. Other losses will result from normal steam leaks and occasional atmospheric steam discharges.

8.3 SITE AREA

8.3.1 Vegetation

Most of the site area vegetation in the immediate vicinity of the powerhouse and switchyard will be removed during the proposed station construction. Some clearing will also take place on the transmission line right-of-way. It is likely that, as part of a landscaping scheme yet to be decided, a program of grading, sodding and planting of shrubs and trees on banks, along roadways and in open areas will be undertaken.

The station operation should have no effect on vegetation in the immediate area. The limited operation of the standby combustion turbine units in their proposed location should not cause any injury to even the most sensitive species of vegetation at any distance from the source.

8.3.2 Wildlife

Some of the wildlife disturbed during the construction phases of the proposed Darlington GS A is expected to return to the less populated areas of the station site after the construction activities have ended.

8.3.3 Shoreline

The reclaimed water lots will be permanently lost to aquatic life. The protected new shoreline will continue to affect the local lake current as well as to deprive it of littoral drift materials by eliminating a part of the source of supply and by trapping some of the drift materials on the edge of the new shoreline. The circulating water discharge channel will be designed to withstand the erosive force of the thermal discharge flow. However, at the end of the channel, the discharge may initially erode some of the fine lake bottom sediments, although this effect is expected to be of short duration.

8.3.4 Personnel

Extensive effort has gone into the design of nuclear power stations with a view to minimizing the radiation and other hazards to which the station operating and maintenance staff may be exposed.

Special procedures have been developed for control of access to areas of high activity or of possible contamination and are practiced in order to keep radiation exposure to a minimum.

8.4 COMMUNITY AND LAND USE

8.4.1 Radiation Dose Considerations

It is essential to ensure that both individual dose limits as well as population dose limits are not exceeded due to the operation of the proposed station. Radiation dose limits for individual members of the public, as set by the AECB and recommended by the ICRP, are given in Section 5.1, Table 5.1.

The derived release limits for the station will be based on the maximum permissible dose to the individual at the exclusion area boundary or on the integrated population dose, whichever is more restrictive. At regular intervals, throughout the life of the station, it will be necessary to calculate the corresponding hypothetical population dose in the area of concern to ensure that the population dose limit is not exceeded. At this time the individual dose is limiting but if the population dose becomes limiting, it will be necessary to reduce the DRL as the population within the integration area continues to grow.

Meeting the 1% of DRL design and operating targets for activity releases will ensure that doses to individuals at the site boundary will be a small percentage of the regulatory limits and that population dose limits will not be approached during the life of the station.

8.4.2 Operating Staff Distribution

The operating and maintenance staff for the proposed station is expected to peak at a yearly average of almost 600 in 1984, and to level off at about 300 by 1991. It is too early at this time to predict a residential location preference ratio for this staff.

8.4.3 Industry

No significant effects of operation of the plant are expected, other than benefits to service industries which will cater to the needs of additional Ontario Hydro staff and their families.

8.4.4 Agriculture

Since the operation of nuclear generating plants does not result in the emission of significant amounts of particulate or gaseous pollutants into the air, effects of these will be minimal on surrounding agricultural activities.

8.4.5 Education

The educational requirements of the relocated operations/maintenance staff and their families should not create a burden on existing facilities.

8.4.6 Medical

Existing medical facilities should be adequate to meet the needs of operating staff and their families.

8.4.7 Transportation

No significant impact on transportation facilities in the area due to operation of the proposed station is anticipated.

8.4.8 Labour Market

Most of the operations/maintenance staff required for the proposed station will likely be relocated from elsewhere, as they require skills obtainable only at other generating stations or at special training centres. No significant effect on the local labour market is therefore expected.

8.4.9 Recreation and Parkland

The operation of the proposed station is not expected to have any effect on the use of recreational and parkland facilities in the area.

8.4.10 Regional Development

Since the number of operations/maintenance staff and their families that would be relocated is small in relation to the general trend of residential relocation to the area, very little effect can be expected on the overall development of the Regional Municipality of Durham.

8.5 NOISE

It is most unlikely that noise emanating from the station to the surrounding community will exceed normal background levels. Preliminary results of studies in progress at the Bruce Nuclear Power Development indicate that sounds generated during normal site operations are not audible at the site boundary. One exception would be the occasional operation of steam discharge valves on the roof during certain shutdown sequences. Silencers have recently been developed and tested that are expected to reduce noise from this operation to below 50 dbA at the property line.

Various measures to be taken to reduce noise levels for the protection of operating staff within the plant may also produce a slight reduction in noise transmitted to the site boundary.

9.0 ALTERNATIVES CONSIDERED

Ontario Hydro has initiated further detailed studies involving alternative methods of waste heat dissipation (Section 9.1), once-through cooling (Section 9.2) and alternative uses of the thermal discharge (Section 9.3). Results of these studies will be presented when available.

9.1 ALTERNATIVE METHODS OF WASTE HEAT DISSIPATION

Once-through cooling has been adopted by Ontario Hydro for thermal generating stations. Rejecting heat directly to the atmosphere using both wet and dry and both natural and mechanical draft has been studied (137).

The use of mechanical draft cooling towers, both wet and dry, has been rejected on the basis of increased unreliability due to increased equipment requirements, space requirements, maintenance and operation requirements, power consumption, noise and cost.

An Ontario Hydro study of natural draft, wet cooling towers summarizes the environmental effects of locating these cooling towers in Ontario. Results of the study indicate that these would involve greater cost. Cold Canadian winters would likely intensify the cold weather environmental effects experienced by American and British users. Plume visibility and subsequent sunlight obscurance would occur in the colder weather.

Cooling ponds have also been investigated. Preliminary calculations indicate that one to two acres of cooling surface would be required for each megawatt of station output (approximately five to ten square miles for the proposed station). The low efficiency of the cooling pond could be increased substantially, resulting in a reduction of the surface area required by as much as a factor of 20, by introducing a spray to the system. Other major disadvantages besides the large land requirements are the high loss of water which could cause ground fogging and/or local icing problems during cold weather, easy entry of airborne impurities and limited cooling range.

Once-through cooling is considered to be the most reliable, efficient and economic of the proposed viable alternatives. Any concerns or claimed environmental influences for once-through cooling on the Great Lakes are not considered to have been sufficiently substantiated to warrant adoption of alternative waste heat dissipation methods with their own potentially adverse environmental effects.

9.2 ALTERNATIVE ONCE-THROUGH COOLING METHODS

9.2.1 Increased Cooling Water Pumping Capacity

Studies have been initiated to examine the installation of extra condenser cooling water pumping capability. This extra capacity will insure that station temperature rises in excess of 20F° or discharge temperatures in excess of 90°F will not occur.

9.2.2 Tempering

Tempering could be used to decrease the temperature of the discharge in order to meet any stricter criteria for upper temperature limits or temperature rise across the station. Tempering would require additional pumping capacity and as a result would entrain more organisms and modify flows. Tempering would result in lower temperatures near the discharge, but the total lake surface area used for heat dissipation would increase due to the larger discharge volume and slower rate of heat loss to the atmosphere.

For the proposed station, based on present knowledge, continuous tempering does not appear to be an alternative which would result in lower overall environmental impact at this site.

9.2.3 Discharge Velocity

The proposed low velocity surface discharge places warm water on the surface so that a maximum rate of cooling to the atmosphere is achieved in the near-shore area. Increasing the velocity of the surface discharge would tend to reduce the surface area of the heated water due to increased vertical and horizontal entrainment of the discharge with the surrounding lake water. Slightly higher temperatures would therefore occur at near-shore depths which may tend to influence the benthic community both by direct heat and by scouring action.

The use of somewhat higher discharge velocities is being investigated to determine if shoreline temperatures and possible recirculation can be reduced during certain wind conditions. Figures 9-1, 9-2 and 9-3 illustrate the thermal plume predictions from the proposed station based on an increased discharge velocity of 6.0 fps.

9.2.4 Submerged Discharge

A submerged offshore discharge, using a lined submerged tunnel to carry the warm discharge water from the shore, may result in fewer occasions when higher temperatures influence the littoral zones. The discharge structure of such a system would have to be raised or directed off the lake bottom to avoid disturbance of lake bottom sediments. Discharge temperatures would be rapidly reduced by

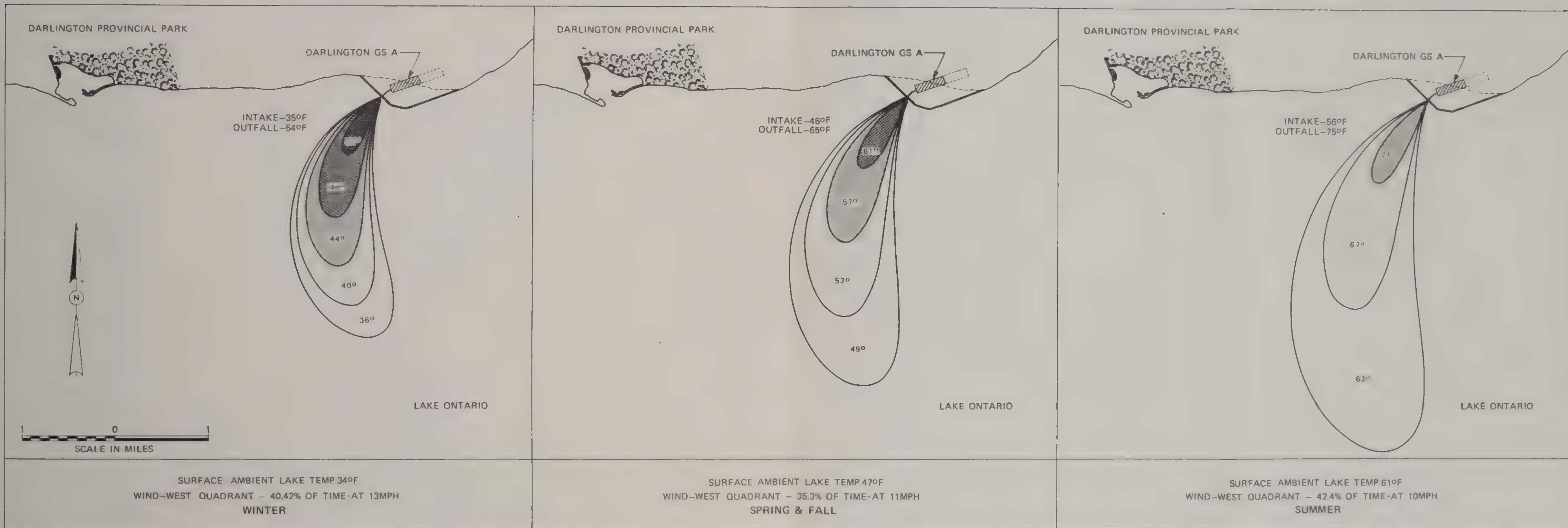


FIGURE 9–1
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WIND FROM THE WEST QUADRANT
– DISCHARGE VELOCITY 6.0 fps

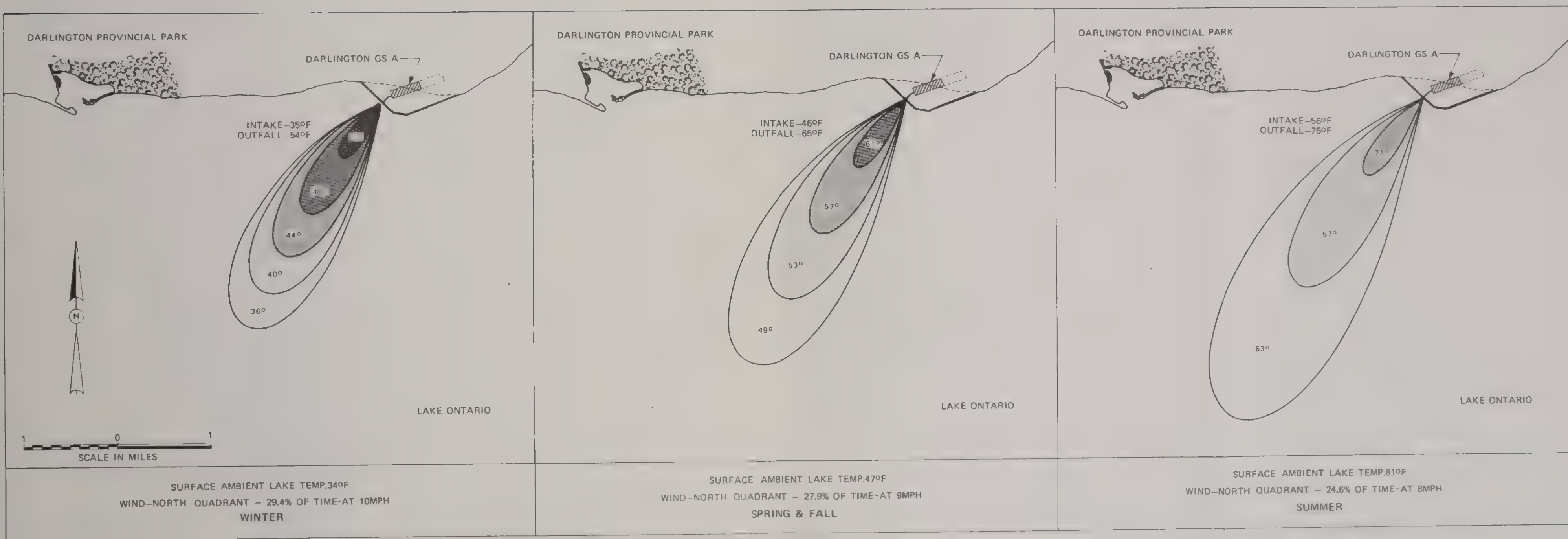


FIGURE 9–2
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WIND FROM THE NORTH QUADRANT
– DISCHARGE VELOCITY 6.0 fps

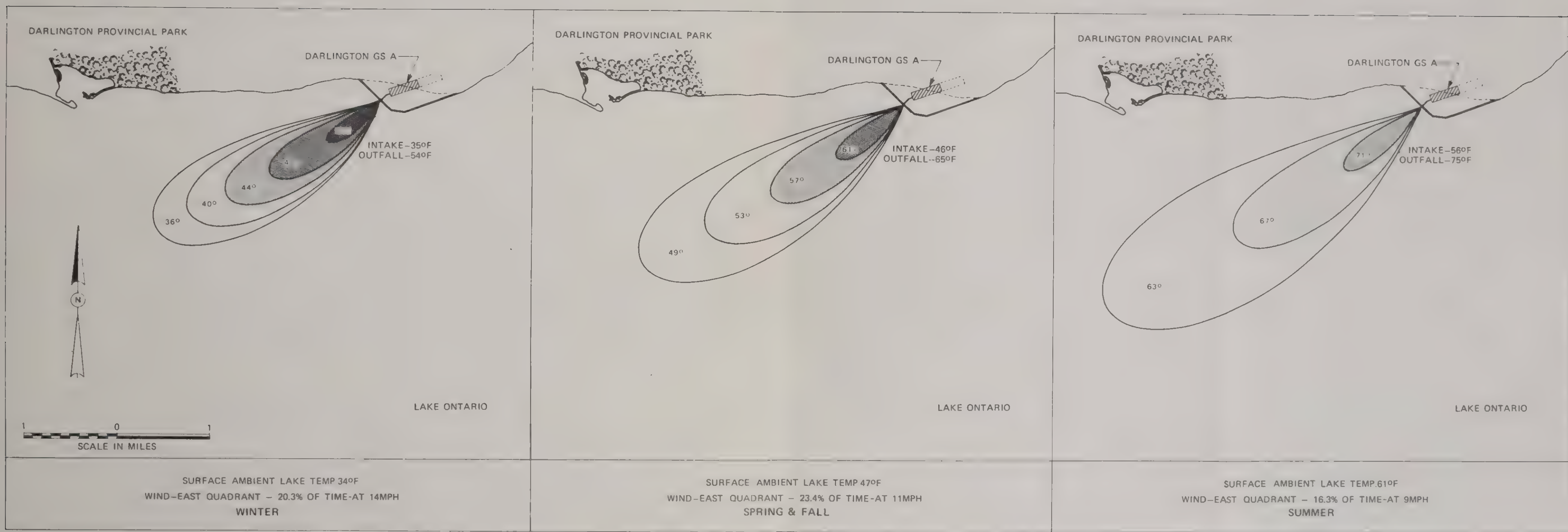


FIGURE 9–3
THERMAL PLUME PREDICTION –
DARLINGTON GS A
– SUBMERGED INTAKE AND OPEN DISCHARGE
– WIND FROM THE EAST QUADRANT
– DISCHARGE VELOCITY 6.0 fps

entrainment with the surrounding colder water body and the resulting surface temperatures would be lower than those for a surface discharge. The loss of heat to the atmosphere would however take place at a slower rate.

Disruption of any existing thermocline and resulting biological effects may be an environmental disadvantage of such a discharge system. A submerged discharge, as opposed to a surface discharge, would result in greater heat retention in the receiving water body due to the reduced rate of heat transfer to the atmosphere from the surface.

No biological data is presently known to be available on the relative merits of shoreline or offshore discharges, which could be used to make a choice based on environmental considerations.

9.2.5 Shoreline Intake

This type of intake would draw in epilimnetic water and some tempering would be required in order to meet existing discharge temperature criteria in the summer months. Other disadvantages would include increased intake of plankton, ice, weeds, silt and debris. One advantage would be that any stratification of the offshore area would not be disturbed to the same degree if the discharge point was also located at the surface. Fish intake may be reduced by a shoreline screening system, but existing information does not indicate that this possible advantage outweighs the numerous and obvious disadvantages of a shoreline intake. A shoreline intake, therefore, does not appear to offer an overall environmental advantage over an offshore intake. Such intakes at Lakeview GS and Pickering GS have had to be subsequently modified to avoid problems such as silt, ice and weed intake.

9.3 ALTERNATIVE USES OF THE THERMAL DISCHARGE

Ontario Hydro is presently undertaking studies to develop uses for the warm water discharge from the proposed station. A concept is being examined to direct the thermal discharge along the shoreline to the west of the site. This would have a warming effect on the near shore area and would allow the development of warm water, public recreational facilities along the shoreline between the Darlington site and Darlington Provincial Park to the west.

Other possibilities include the use of the warm water discharge for aquaculture. The concept of fish hatcheries is presently being examined by consultants for Environment Canada and the proposal will be examined in relation to the construction program for possible incorporation if the Darlington site is preferred over others. A fish hatchery will create an artificial productivity potential well in excess of the productivity of the littoral area occupied by the site.

Use of some of the warm water for increasing greenhouse productivity and for the concept of district heating have been proposed. However, the low quality heat available may not be, by itself, an adequate source of heat for such schemes. Each of these uses is presently being examined.

9.4 ALTERNATIVE SHORELINE RECLAMATION SCHEMES

The utilization of the Darlington site must consider a relatively small site area, the bisection of the site by the C.N.R. tracks and the topography. The initial site layout study proposed that Ontario Hydro reclaim approximately 200 acres of land along the shoreline. This proposal resulted in a study of three cofferdam schemes (138):

(a) completely rockfilled.

(b) completely dumped till.

(c) rockfill for the western half and dumped till for the eastern half.

Subsequent to this study, another was initiated to investigate the raising of the powerhouse grade to reduce shoreline reclamation (38). This study determined the optimum elevation for the powerhouse and determined the relative cost of having the maximum powerhouse grade at elevation 310. These studies resulted in the final recommended proposal, as discussed in Section 4.10.3, to develop only the western portion of the site by reclaiming approximately 120 acres of land behind a rockfilled cofferdam.

The proposed scheme and that of the mixed cofferdam scheme were considered to be the more acceptable. Rockfilled cofferdams would tend to stabilize the eroding shoreline and reduce the littoral drift material in the area. The uncertainties at this time associated with the construction of dumped till cofferdams of this nature and the decision to develop only that area of the site for the proposed station and a possible future extension resulted in the adoption of the proposed scheme (Section 4.10.3) over the mixed cofferdam proposal.

9.5 ALTERNATIVE CONDENSER CLEANING METHODS

Mechanical methods of condenser tube cleaning are being investigated. An Amertap system has been installed on one unit at Nanticoke GS for a comparative study with chlorination. Provision will be made for mechanical cleaning installation at Darlington GS A.

10.0 GLOSSARY OF TERMS

This glossary lists and defines a number of frequently used terms not normally found in a dictionary, or used in a context which differs from the normal:

Absorbed dose	-	when ionizing radiation passes through matter, some of its energy is imparted to the matter. The amount absorbed per unit mass of irradiated material is called absorbed dose, and is measured in 'rads'.
Acclimation temperature	-	the temperature at which an organism, after a period of constant exposure, achieves a stable response when exposed to stress.
Biochemical oxygen demand (BOD)	-	the quantity of oxygen consumed by microorganisms to stabilize the organic matter in a body of water.
Bloom	-	a high density growth, usually of algae, imparting a turbidity or colour to water.
Blowdown	-	the intermittent discharge of boiler water to reduce the concentration of impurities which remain in the boiler during the evaporation of feedwater.
Cladophora	-	a branched, filamentous green alga which has special hold-fast organs. It grows in enriched waters, attached to shallow lake locations.
Decibel (db)	-	the standard measure of noise or sound pressure level, expressed as a logarithmic ratio of the sound pressure of a given noise with respect to a reference sound pressure which is commonly taken as 0.0002 microbars in the context of sound and human hearing. For many types of noise sources found in urban or industrial areas, a frequency weighting scale designated as "A" gives good correlation between measured noise levels and judged human annoyance. Readings using this scale are reported as A-levels in decibels, abbreviated dbA.

Derived release limits (DRL)	-	estimates of the maximum permissible average release rates if compliance with the maximum permissible dose for members of the public is to be ensured.
Epilimnion	-	the uniformly warmer and turbulent superficial layer of a lake when it is thermally stratified during summer. The layer above the thermocline.
Final preferendum	-	the point at which the selected temperature is equal to the acclimation temperature.
Fumigation	-	the downward dispersion of emissions associated with a marked difference in stability between air above a stack plume and a relatively unstable layer below the plume. Condition develops from the ground upward as the rising sun heats the ground, resulting in higher than normal ground level concentrations.
Heavy water (D_2O, deuterium oxide)	-	water containing significantly more than the natural proportion (1 in 6500) of heavy hydrogen (deuterium) atoms to ordinary hydrogen atoms. Heavy water is used as a moderator and heat transport fluid in the PHW CANDU reactor because it slows down neutrons effectively and also has a low cross section for absorption of neutrons.
Hypolimnion	-	the uniformly cold and deep layer of a lake when it is thermally stratified during summer. The layer below the thermocline.
Lapse rate	-	the rate of change of temperature with height above the ground.
Man-Rem	-	the number of men times the averaged whole body dose absorbed by each man.
Median tolerance limit (TLm)	-	the concentration of a toxic material such that 50% of the test organisms will succumb over a standard exposure time, such as 24, 48 or 96 hours.

Plume (thermal)	-	the area of a body of water which is influenced by the thermal discharge, temperature being measurably higher than ambient conditions.
Rem (Roentgen equivalent man)	-	the unit of dose equivalent of any ionizing radiation which produces the same biological effect as a unit of absorbed dose of ordinary X-rays.
Selected temperature	-	the temperature most frequently chosen by organisms in a temperature gradient.
Stability	-	the tendency of the atmosphere to resist or increase vertical motion as defined by temperature lapse rate and wind shear.
Tempering	-	the process whereby condenser discharge water is mixed with lake water to reduce its temperature before returning to the lake.
Thermal stratification	-	the layering of bodies of water having different heat contents.
Thermocline	-	a layer of water in which temperature differences exceed 1C^{o} for each metre of depth.

11.0 REFERENCES

1. Letter from F.C. Boyd to J.S. Foster, June 10, 1964 Pickering Safety Report, Vol. 1, Appendix G.

2. Hurst, D.G. and F.C. Boyd. Reactor Licensing and Safety Requirements, 1972 CNA Annual Conference, Paper No. 72-CNA-102.

3. Radiation Protection Regulations, Part 1. Nuclear Electric Generating Stations, Ontario Hydro publication.

4. The Environmental Protection Act, 1971: Statutes of Ontario, 1971, Chapter 86.

5. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Summary report to the International Joint Commission. Vol. 1, 1969.

6. Statement issued by the International Commission on radiological protection after its meeting in November 1972. ICRP/72/G-4.

7. Boyd, F.C. Containment and siting requirements in Canada, Atomic Energy Control Board, presented to IAEA, Vienna, April 1967.

8. ICRP Publication 9, 1966.

9. Wong, K.Y. Basis for the derived limits for the release of radionuclides in gaseous and liquid effluents from Ontario Hydro's nuclear stations. Health Physics Department Report No. HPD-73-6, Rev. 1, August, 1974.

10. Bryant, P.M. Methods of estimation of the dispersion of windborne material and data to assist in their application. Radiological Protection Division, Health and Safety Branch, U.K. Atomic Energy Authority, 1964.

11. Radioactive emissions and their control. Chapter 3, Environmental Design Manual, Generation Projects Division, 1973.

12. Guidelines and Criteria for Water Quality Management in Ontario. Ontario Water Resources Commission, June 1970.

13. Brown, D.N., et al. The climate of southern Ontario climatological studies No. 5. Canadian Department of Transport, Toronto, 1968.

14. The data and pan operators. Atlas of Climatic Maps, Canadian Department of Transport, Toronto, 1970.

15. Wong, Y.S. The climatology of Wesleyville. Operating Department Report, Ontario Hydro, 1972.

16. Pasquill, F. The estimation of the dispersion of windborne material. The Meteorological Magazine, 90, 33, 1971.

17. Djurfors, S.G. The vertical distribution of temperature on selective days in the vicinity of Metro Toronto. Research Division Report 71-363-H, October 13, 1971.

18. Climatic information for building design in Canada. Supplement No. 1 to the National Building Code of Canada, 1970. National Research Council of Canada, Associate Committee on the National Building Code, Ottawa, NRC 11153.

19. Complak, J. Water analysis for aquatic biological studies Bowmanville. Research Division Reports CI73-158-K, CI73-171-K and CI73-215-K, 1973.

20. Canada Centre for Inland Waters, Canadian Oceanographic Data Centre, Limnogical Data Reports, Lake Ontario, 1966 to 1969.

21. Dobson, H.H. Principal ions and dissolved oxygen in Lake Ontario. Proceedings, Tenth Conf. Great Lakes Research, 337, 1967.

22. Chau, Y.K., V.K. Chawla, H.F. Nicholson and R.A. Vollenweider. Distribution of trace elements and chlorophyll in Lake Ontario. Proceedings, Thirteenth Conf. Great Lakes Research, 659, 1970.

23. Shiomi, M.T. and V.K. Chawla. Nutrients in Lake Ontario. Proceedings, Thirteenth Conf. Great Lakes Research, 715, 1970.

24. Johnson, A.F. Preliminary environmental study - aquatic biology - Bowmanville Site - 1972. Research Division Report 73-127-H, April 1973.

25. Pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River. Report to the International Joint Commission. Vol. 3. Lake Ontario and the International Section of the St. Lawrence River. 1969.

26. Menon, A.S., B.J. Dutka and A.A. Jurkovic. Preliminary bacteriological investigation of the Lake Ontario thermal bar. Proceedings, Fourteenth Conf. Great Lakes Research, 59, 1971.

27. Waino, A. and J. Rowsell. Fishing along the Lake Ontario waterfront in the Toronto-Centred region. Department of Lands and Forests, 1971.

28. Lindsay District - Inventory of the natural resources of the Lake Ontario shore between Oshawa and Wellers Bay. Ministry of Natural Resources, 1972.

29. Munawar, M. and A. Nauwerck. The composition and horizontal distribution of phytoplankton in Lake Ontario during the year 1970. Canada Centre for Inland Waters, Burlington, Ontario.

30. Neil, J.H. and G.E. Owen. Distribution, environmental requirements and significance of Cladophora in the Great Lakes. In: Proceedings, Seventh Conference on Great Lakes Research, Great Lakes Research Division, Publication No. 11, 1964.

31. Water Supply Study, Village of Newcastle, June 1973.

32. Metropolitan Toronto key facts. Metropolitan Toronto Planning Board, April 1970.

33. Population and employment forecasts for 1981. Metropolitan Toronto Transportation Plan Review, September 1973.

34. Regional government report. OAPADS, June 1971.

35. Proposed official plan of the Oshawa Planning Area, adopted by the Oshawa City Council on November 15, 1973.

36. Proposed Amendment No. 8 to the Official Plan of the Darlington Planning Area, adopted by the Council of the former Township of Darlington on November 13, 1973.

37. Air quality criteria for particulate matter. Environmental Protection Agency, Air Pollution Control Office, Washington, D.C., January 1969.

38. Ontario Hydro memorandum from J. Deans to R.M. Burnard. Darlington GS site grading study, July 3, 1974.

39. Lennox Generating Station, cooling water intake contract, earth excavation and disposal, review of results of turbidity monitoring. Ontario Hydro, Generation Projects Division, Report No. 177-68, June 1973.

40. Summary of wind recorded at Wesleyville Generating Station Site. Ontario Hydro, Hydraulic Studies Department, June 1974.

41. Climatic normals. Vol. V, Winds. Department of Transport, 1968.

42. Letter from J.W. Rousom, Commercial Fish Section, Commercial Fish and Fur Branch, Ministry of Natural Resources to R.A. Sogawa, Generation Concept Department, Ontario Hydro, June 25, 1974.

43. Guide for licensing of radioactive waste management facilities. Atomic Energy Control Board Information Bulletin 74-1, January 7, 1974.

44. Soil capability for agriculture, Toronto-30M. Canada Land Inventory Map, ARDA, Ministry of Agriculture and Food, 1968.

45. ARDA map No. Rec-30M/15.

46. Atomic Energy Control Act, SOR/74-334. June 4, 1974.

47. Yocom, T.G. and T.A. Edsall. Effect of acclimation temperature and heat shock on vulnerability of fry of Lake Whitefish (Coregonus clupeaformis) to predation. J. Fisheries Res. Board Canada, 31:1503-1506, 1974.

48. Ritchie, G.A. and J.W. Speakman. Effects of settling time on quality of supernatant from upland dredge disposal facilities. Proceedings, Sixteenth Conf. Great Lakes Research, 321, 1973.

49. Pickering GS Quarterly Technical Reports, 1973 and 1974. Ontario Hydro.

50. Memorandum from G.A. Pearce, Program Engineer, Water Quality Branch, Ministry of the Environment to D.L.S. Bate, Manager of Engineering, Bruce Heavy Water Plant, Ontario Hydro regarding Bruce Heavy Water Plant Intake, Discharge Channel and Disposal Areas Approval, April 2, 1974.

51. Johnson, A.F. Biological studies - Lakeview GS, 1971. Ontario Hydro Research Report 72-46-H, 1972.

52. Lee, G.F. and G.D. Veith. Effects of thermal discharges on the chemical parameters of water quality and eutrophication. International Symposium on Identification and Measurement of Environmental Pollutants, Ottawa, Canada, June 1971.

53. Davidson, B. and R.W. Bradshaw. Thermal pollution of water systems, Envir. Sci. and Tech. 1: 618-630. 1967.

54. Effer, W.R. 1969 Dissolved oxygen in thermal generating station cooling water. Ontario Hydro Research Quarterly, 21 (3) 19-20.

55. Streeter, H.V. and E.B. Phelps. A study of the pollution and natural purification of the Ohio River. Public Health Bulletin 146. U.S. Public Health Service, Washington, 1925.

56. Dobbins, W.E. BOD and oxygen relationships in streams. I. San. Eng. ASCE Proc. 90 SAE3. p 53, 1964.

57. Miller, D.C. and A.D. Beck. Development and application of criteria for marine cooling waters. Symposium on the Physical and Biological Effects on the Environment of Cooling Systems and Thermal Discharges at Nuclear Power Stations, IAEA-SM-187/10, Oslo, August 26-30, 1974.

58. Everest, G.L. Some effects of heated effluents on fish populations at three thermal generating stations. M. Sc. Thesis, University of Toronto, 1973.

59. Kelso, J.R.M. Movement of Brown Bullhead (Ictalurus nebulosus) in a thermal effluent as determined by ultrasonic tracking. J. Fisheries Res. Board Canada, 31, pp 1507-1513, 1974.

60. Hathaway, E.S. Quantitative study of changes produced by acclimatization in the tolerance of high temperatures by fishes and amphibians. Tulane University of Louisiana, 1927.

61. Ferguson, R.G. The preferred temperature of fish and their mid-summer distribution in temperate lakes and streams. J. Fisheries Res. Board Canada 15 (4): 607-624, 1958.

62. Graham, T.J. Observations on the alewife, pomolobus pseudoharengus (Wilson) in fresh water. University of Toronto, Biological Series No. 62, p 43, 1956.

63. Industrial waste guide on thermal pollution. Pacific Northwest Water Laboratories, FWPCA, September 1968.

64. McCauley, R.W. and L.A.A. Read. Temperature selection by juvenile and adult yellow perch (Perca flavescens) acclimated to 24°C. J. Fisheries Res. Board Canada 30, 1253, 1973.

65. R.E. Ginna Nuclear Power Plant, Unit 1, final environmental impact statement. Docket 50-244 USAEC, December 1973.

66. Cheney, P.P. A systems analysis of aquatic thermal pollution and its implications. TRC Report 7743-341 (b), January 1969.

67. Pitt, T.K., E.T. Garside and R.L. Hepburn. Temperature selection of the carp (Cyrinus carpio Linnaeus). Can. J. Zool. 34, pp 555-557, 1956.

68. Hart, J.S. Geographic variations of some physiological and morphological characteristics in certain fresh water fish. University of Toronto, Biological Series No. 60, p 79, 1952.

69. Indian Point 2, Draft environmental impact statement. Docket 50-250 USAEC, April 13, 1972.

70. Environmental Biology. Fed. Amer. Soc. Exptl. Biol., Bethesda Md., Altman, P.C. and Dittmer, D.S. eds., p 694, 1966.

71. Van Oosten, J. The smelt, Osmerus mordax (Mitchell). Mich. Cons. Dept., p 13, 1940.

72. Wurtz, C.B. and C.E. Renn. Water temperatures and aquatic life. Cooling water studies for Edison Electric Institute Research Project RP-49, Edison Electric Institute, EEI Pub. 56-901, New York, N.Y., 1965.

73. Garside, E.T. and J.S. Tait. Preferred temperature of rainbow trout (Salmo gairdneri, Richardson) and its unusual relationship to acclimation temperature. Can. J. Zool., 36, pp 563-567, 1958.

74. Carlander, K.D. Handbook of fresh water fishery biology, Vol. 1. Iowa State University Press, Ames, Iowa, 1969.

75. Brett, J.R. Some lethal temperature relationships of Algonquin Park fishes. University of Toronto, Biological Series No. 52, p 49, 1944.

76. Brett, J.R. Temperature tolerance in young pacific salmon genus Oncorhynchus, J. Fisheries Board Canada 9,265, 1952.

77. Hart, J.S. Lethal temperature relations of certain fish in the Toronto region. Trans. R. Soc. Can. 41, pp 57-71, 1947.

78. Vermont Yankee NPS, final environmental impact statement, USAEC docket No. 50-271, 1972.

79. Brett, J.R. Some principles in the thermal requirements of fishes. Quarterly Rev. Biol. 31 (2), 75-87, 1956.

80. Novotny, A.J. Importance of river temperature in the main streams of the Columbia and Snake rivers in the relation to the survival of salmon. In: Fish Passage Res. Prog. Rev. Progress, Vol. 5, Adaptability of salmon to new environments created by dams. U.S. Fish Wildlife Serv., Bur. Commer. Fish., Seattle, Wash., 1964.

81. Coutant, C.C. Biological aspects of thermal pollution, II. Scientific basis for water temperature standards at power plants. CRC Critical Reviews in Environmental Control 3, p 1, 1972.

82. Fry, F.E.J., J.R. Brett and G.H. Clawson. Lethal limits of temperature for young goldfish. Rev. Can. Biol. 1, p 50, 1941.

83. Black, E.C. Upper lethal temperatures of some British Columbia fresh water fishes. J. Fisheries Res. Board Canada 10: p 196, 1953.

84. 1969 Fish kills caused by pollution. FWQA 1970. U.S. Government Printing Office, Washington, D.C.

85. Fish kills produced by pollution 1971. U.S. Environmental Protection Agency, 1972.

86. Fish kills produced by pollution 1970. U.S. Environmental Protection Agency, 1972.

87. Coutant, C.C. Biological aspects of thermal pollution. I. Entrainment and discharge canal effects. CRC Critical Reviews in Environmental Control. I (3), pp 341-381, 1970.

88. deSylva, O.P. Theoretical considerations on the effects of heated effluents on marine fish. In: Biological Aspects of Thermal Pollution. P.A. Krenkel and F.L. Parker (eds.), Vanderbilt University Press, pp 229-293, 1969.

89. McCauley, R.W. Research on mortality of fish in thermal effluents. Studies in Progress, Ontario Hydro Executive Approval No. 148/74, May 13, 1974.

90. Berst, A.M. and G.R. Spangler. Lake Huron: Effects of exploitation, introductions and eutrophication on the salmonid community. J. Fisheries Res. Board Canada 29 (6): pp 877-887, 1972.

91. Letter from R.W. McCauley to W.R. Effer. Temperature preferences in American Smelt, July 5, 1974.

92. Service, D.R. The biological effects of entrainment: Literature review and study proposal. Generation Projects Division, Ontario Hydro, August 1973.

93. Marcy, B.C. Survival of young fish in the discharge canal of a nuclear power plant. J. Fisheries Res. Board Canada 28 (7): pp 1057-1060, 1971.

94. Environmental statement - Monticello Nuclear Generating Plant. USAEC, Oak Ridge, Tennessee, 1972.

95. Draft environmental statement - Donal C. Cook Nuclear Plant Units 1 and 2. USAEC, Oak Ridge, Tennessee, 1972.

96. Environmental statement - Connecticut Yankee Nuclear Power Station. USAEC, Oak Ridge, Tennessee, 1972.

97. Environmental statement - Shoreham Nuclear Power Station. Docket No. 50-322, 1972.

98. Patrick, R. Some effects of temperature on freshwater algae. In: Biological Aspects of Thermal Pollution. P.A. Krenkel and F.L. Parker, (eds.), Vanderbilt University Press, pp 161-185, 1969.

99. Zion Nuclear Power Station - final environmental impact statement for Units 1 and 2, Commonwealth Edison Company. Dockets 50-295, 50-304, December 1972, USAEC Directorate of Licensing.

100. Markowski, S. The cooling water of power stations: A new factor in the environment of marine and freshwater invertebrates. J. Anim. Ecol., Vol. 28, pp 243-258, 1959.

101. Morgan, R.P. and R.G. Stross. Destruction of phytoplankton in the cooling water supply of a steam electric station. Chesapeake Sci., Vol. 10, pp 229-293.

102. Whitehouse, J.W. Some aspects of the biology of Lake Transfyndd; a power station cooling pond. Hydrobiologia 38 (2): pp 258-288, 1971.

103. DeMont, D.J. and R.W. Miller. First reported incidence of Gas-Bubble disease in the Heated Effluent of a Steam Generating Station. 25th Annual Southwestern Assoc. Game & Fish Commissioners. October 17-20, Charleston, South Carolina, 1971.

104. Johnson, A.F. Gas bubble disease in fish. Ontario Hydro Research Report 73-61-H, 1973.

105. Johnson, A.F. Biological studies - Pickering GS. Ontario Hydro Research Report 72-46-H, 1972.

106. Johnson, A.F. Biological studies - Pickering GS. Ontario Hydro Research Report 73-107-H, 1973.

107. Griffiths, J.S. Aquatic biological studies - Pickering GS 1970-1973. Ontario Hydro Research Report 74-78-H, 1974.

108. Temperature and aquatic life. Laboratory investigations - No. 6. F.W.P.C.A. U.S. Dept. Interior 1967.

109. Churchill, M.A. and T.A. Wojtalik. Nuclear News 80, 1969.

110. Environmental statement - James A. Fitzpatrick, Nuclear Power Plant. USAEC, Oak Ridge, Tennessee, 1973.

111. Proposed generating station B for Pickering. Environmental assessment, Ontario Hydro, April 1974.

112. Peach Bottom Atomic Power Station Units 2 and 3, environmental statement, Docket Nos. 50-277 and 50-278, 1973.

113. Brungs, W.A. Effects of residual chlorine on aquatic life. J.W.P.C.F., 45, 10, p 2180, 1973.

114. Arthur, J.W. and J.G. Eaton. Toxicity of chloramines to the amphipod, gammarus pseudolimnaeus, (Bousfield), and the fathead minnow, pimephales promelas, (Rafinesque). J. Fisheries Res. Board Canada, 1972.

115. Arthur, J.W. Progress reports. National Water Quality Laboratory, Duluth, Minnesota, 1971.

116. Arthur, J.W. Progress reports. National Water Quality Laboratory, Duluth, Minnesota, 1972.

117. Basch, R.E. In-situ investigations of the toxicity of chlorinated municipal waste water treatment plant effluents to rainbow trout (salmo gairdneri) and fathead minnows (pimephales promelas). Bureau of Water Management, Michigan Dept. of Nat. Res., Lansing, Michigan, 1971.

118. Biesinger, K.E. Personal communication. National Water Quality Laboratory, Duluth, Minnesota, 1971; described in letter from O. Sisman, ORNL, to J. Cusack, USAEC, January 15, 1973 (Docket Nos. 50-277 and 50-278).

119. Coventry, F.L., V.E. Shelford and L.F. Miller. The conditioning of a chloramine treated water supply for biological purposes. Ecology, 16, pp 60-66, 1935.

120. Dandy, J.W.T. The effects of chemical characteristics of the environment on the activity of aquatic organism. Thesis, University of Toronto, 1967. Dissertation Abstracts, 29, p 3132 (1969), Water Pollution Abst. (Brit.) 42, 1708 (1969).

121. Forbes, R.L. Chlorine toxicity and its effect on gill tissue respiration of the white sucker, catostomus commersoni (Lacépède). M.S. thesis, Dept. of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, 1971.

122. Hale, F.E. Control of microscopic organisms in public water supplies with particular reference to New York City. New Engl. Water Works Assoc. 44, pp 361-385, 1930.

123. Holland, G.A. et al. Toxic effects of organic and inorganic pollutants on young salmon and trout. State of Washington, Dept. of Fisheries Research Bulletin No. 5, pp 198-214, September 1960.

124. Merkens, J.C. Studies on the toxicity of chlorine and chloramines to the rainbow trout. Water and Waste Treat. J. 7, pp 150-151, 1958.

125. Pyle, E.A. Neutralizing chlorine in city water for use in fish distribution tanks. Prog. Fish-Cult., 22, pp 30-33, 1960.

126. Sprague, J.B. and D.E. Drury. Avoidance reactions of salmonid fish to representative pollutants. In: Advances in Water Pollution Research, Proceedings of the 4th International Conf., pp 169-179, 1969.

127. Taylor, R.S. and M.C. James. Treatment for removal of chlorine from city water for use in aquaria. U.S. Bur. Fish. Doc. No. 1045, Rept. U.S. Comm. Fish. App. 7, pp 322-327, 1928.

128. Truchan, J.G. Personal communication (through Brungs, W., EPA), Mich. Water Res. Comm., Lansing, Mich., 1971; described in letters from O. Sisman, ORNL to J. Cusack, USAEC, January 15, 1973. (Docket No. 50-277 and 50-278).

129. Tsai, C. Water quality and fish life below sewage outfalls. Progress report, Natural Resources Institute, University of Maryland, College Park, Maryland, 1971.

130. Zillich, J.A. The toxicity of the Wyoming Wastewater Treatment Plant effluent to the fathead minnow and the white sucker, July 28 - August 1, 1969. Mich. Water Res. Comm., Mich. Dept. of Nat. Res., 1969.

131. Zillich, J.A. The toxic effects of the Grandville Wastewater Treatment Plant effluent to the fathead minnow, pimephales promelas, November 17-21, 1969. Mich. Water Res. Comm., Mich. Dept. of Nat. Res., 1969.

132. Zillich, J.A. The toxicity of the Wyoming Wastewater Treatment Plant effluent to the fathead minnow, December 8-12, 1969. Mich. Water Res. Comm., Mich. Dept. of Nat. Res., 1969.

133. Cole, S.A. and R.J. Baker. Pollution aspects of residual chlorine in cooling and wastewater discharges. 34th International Water Conference of the Engineers' Society of Western Pennsylvania, October 1973.

134. Nine Mile Point Nuclear Station Unit 2, Final Environmental Impact Statement, Docket-50-410, USAES, June 1973.

135. Mortimer, C.H. Chemical exchanges between sediments and water in the Great Lakes - speculations on probable regulatory mechanisms. Limnol. and Oceanog., 16, 387, 1971.

136. Zahn, M. Jahreszeitliche Veranderungen der Vorzugstemperaturen von Scholle (Pleuronectes platessa Linne) and Bitterling (Rhodeus sericeus Pallas) (Seasonal variations in the preferred temperatures of plaice and bitterlings). Verhandlungen der Deutchen Gesellschaft in Munchen 1963, Akademische Verlagsgesellschaft Geest and Portig, Leipzig, 1963 (Provisional translation by McCauley, R.W., Dept. of Biol., Wilfred Laurier University, Waterloo, Ontario).

137. Wet cooling towers and their environmental effects if located in Ontario. Report No. 177-61, Ontario Hydro, January 1973.

138. Bowmanville GS shore protection and reclamation. Report No. 973/NK23-02114, Ontario Hydro, April 1974.

139. Sparling, T.W. An evaluation of alternative routes for the Solandt Commission's public inquiry into the transmission of power between Lennox and Oshawa, October 7, 1974.

140. Ontario Hydro - Wesleyville meteorological survey. Acres Consulting Services Ltd., August, 1974.